Innovation ecosystems in practice

Recommendations for policies, practices, and processes for the performance of innovation ecosystems

Catherine Beaudry

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Preface

Catherine Beaudry

> The aim of 4POINT0 is to answer the following question: How can Canada take advantage of its strength in science and technology to build innovation ecosystems that contribute to innovation and economic development?
> — Catherine Beaudry

Addressing society's challenges requires new ideas, technologies and innovations that cannot be developed in isolation. The unprecedented collaboration needed forces a rethinking of the relationships between policymakers, decision-makers, academics, experts and users. While Canada's science and technology (S&T) performance is outstanding, it still ranks near the bottom among OECD countries in terms of innovation performance. This paradox remains a puzzle for policymakers and industry leaders.

Innovation ecosystems that are well coordinated and well supported in terms of policies, processes and practices may act as the proverbial 'missing link' between S&T and successful commercialisation. These served as the premises on which the Partnership for the Organisation of Innovation and New Technologies (4POINT0) based its arguments and research.

Nowadays, the term 'ecosystem' is used in several different contexts, and it dominates the dialogue on innovation, gradually replacing once-dominant concepts such as industrial districts, clusters and networks.

As the world develops and complexifies in a system embedded in interdependency, the concept, borrowed from ecology, becomes increasingly relevant. By bringing together and synthetising the work of 4POINT0 researchers, we aim to demystify the reality behind the often overused term *ecosystem* and define its true role as a value creator.

Acknowledgements

This white paper is the culmination of seven years of work, not to mention the many months and years spent preparing the grant applications that led to funding for the Partnership for the Organisation of Innovation and New Technologies (4POINT0). I would first like to thank the Quebec Research Funds – Society and Culture (FRQSC), the Social Sciences and Humanities Research Council of Canada (SSHRC), and the Canada Foundation for Innovation (CFI) for their financial support of 4POINT0, as well as Mitacs and the many partners who contributed placements, allowing us to conduct fieldwork in a mutually beneficial close collaboration. Such contributions were invaluable, especially those of CIRANO, which welcomed us on many occasions, as well as BETA, HÉC-Mosaic, the TransMedTech Institute, Innovation, Science and Economic Development Canada (ISED), CAE, Thales, Open Innovation Dominique Sauvé (OIDS), Statistics Canada, Aéro-Montréal, the Conseil de l'innovation du Québec, and others. I do not have space to name all of our partners here, but the full list appears on our website (https://www.4point0.ca/en/partenaires/).

Such a partnership obviously relies on the expertise and collaboration of many people from diverse backgrounds. The co-authors of the white paper's chapters, namely Fabiano Armellini, Mario Bourgault, Anas Ramdani and Sophie Veilleux, deserve my deepest gratitude for their major contributions to the conceptualisation and writing of the work, and especially for their patience while I bombarded them with emails (and sometimes texts). Equally important for understanding and contextualising the ideas in this white paper are the various contributors of specific paragraphs, boxed items and quotations, to whom I am very grateful: Arman Aksoy, Carl-Éric Aubin, Suzanne Benoît, Patrick Cohendet, Pietro Cruciata, Coralie Gagné, Marie Gruber, Mikaël HérouxVaillancourt, Alain Lemieux, Gonzalo Lizarralde, Octave Niamié, Annie Passalacqua, Davide Pulizzotto and Dominique Sauvé. Many of the quotations and other comments were drawn from webinars and conferences organised by 4POINT0 (namely, Anchor 4POINT0 and Technical 4POINT0). These knowledge mobilisation activities, and particularly the discussions that followed the webinars, were very instructive and indirectly guided the authors' writing. Once again, there are too many individuals to name here, but they can all be found on our website (https://www.4point0.ca/en/evenements/). Their remarks remain relevant, and I encourage interested readers to go listen to them.

This white paper would not be so professionally and artfully designed to showcase our words without the considerable input and advice of our webmaster and graphic designer Martin Dozois, not to mention the conceptual work on the 4POINT0 logo, many years ago, by Bénédicte Stordeur, graphic designer at Polytechnique Montréal. I would also like to extend my warmest thanks to Nicolas Sacchetti, our resident journalist and science communication specialist, for his contribution, which greatly facilitated our efforts to communicate the most important aspects of these mobilisation activities. Finally, we would never have been able to produce such a white paper without the impeccable project management of Marine Echternach, and then Mikaël Héroux-Vaillancourt. We owe them a debt of gratitude.

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Anas Ramdani earned his PhD in industrial engineering from Polytechnique Montréal. His thesis focused on the emergence and orchestration of innovation ecosystems within a global technopolitical context, using the case of 5G. His work demonstrated how temporary structures, such as consortia, collaborative projects, or ad hoc partnerships, help to coordinate heterogeneous actors, manage technological and institutional interdependencies, and strengthen network resilience. He also studied the influence of

geopolitical tensions and power asymmetries on the governance of scientific and industrial collaborations. His research employs a multi-method approach, combining interviews, network analysis, text mining, and quantitative modelling to better understand how science, technology, and innovation ecosystems are configured, transformed, and stabilised.

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Executive Summary

The imperative for a new ecosystemic approach to innovation

Despite Canada leading the OECD league tables in terms of private investment in higher education research and development (HERD) and its institutions generating world-class research and inventions, Canadian firms do not invest in converting those outputs into high-value products and services. In an era of intense global competition and rapid technological change, the capacity of a nation to translate its scientific and technological (S&T) strengths into tangible economic and societal impact is paramount. The country hence continues to face challenges in this crucial transformation, reflected in stagnating productivity and a middling international innovation ranking. This white paper posits that overcoming this 'Canadian paradox' requires a fundamental shift from linear, siloed policy approaches to a sophisticated, systemic understanding and nurturing of innovation ecosystems.

This executive summary synthesises the critical findings of our research, offering a strategic framework for policymakers, ecosystem orchestrators, business leaders, and academic researchers to foster and leverage these vital networks for national prosperity. It explores the nature of innovation ecosystems, the critical function of their orchestration, the essential processes and practices that drive them, the role of public policy in their support, and the complex challenge of measuring their performance and impact.

Different types of ecosystemic perspectives

To intervene effectively, policymakers and ecosystem orchestrators must first appreciate the distinct roles and vital interdependencies within the broader innovation landscape. Innovation does not generally occur in isolation but across a continuum of interconnected ecosystems that together form the cycle of value creation and appropriation. We delineate four principal types of ecosystems, each with a distinct focus, yet inextricably linked in the value creation and capture chain.

- **Knowledge ecosystems (KE)**: The genesis of innovation. Centred around universities and public research institutions, these ecosystems focus on foundational, pre-competitive knowledge creation – generating the ideas, scientific advances, publications, and patents that form the bedrock of future technologies.
- **Innovation ecosystems (IE)**: The nexus of value creation. This is where the outputs of knowledge and entrepreneurial ecosystems are leveraged. Heterogeneous actors collaborate to develop new products, services, and business processes, focusing on co-creating value that no single actor could achieve alone.
- **Entrepreneurial ecosystems (EE)**: The engine of new venture creation. These ecosystems provide the fertile ground – culture, capital, mentorship, and networks – for science-based ventures and innovative start-ups to emerge and grow, transforming knowledge into nascent commercial entities.
- **Business ecosystems (BE)**: The arena of value capture. Dominated by firms, these ecosystems are oriented towards commercialisation, scaling, and securing

competitive advantage in the marketplace. They focus on capturing the economic and social value generated within the innovation ecosystem.

The critical insight for policymakers is that these are not discrete, independent entities. They are deeply intertwined. Innovation ecosystems emerge as the central 'connector', bridging the S&T outputs of knowledge ecosystems with the commercialisation focus of business ecosystems, while nurturing the ventures born from entrepreneurial ecosystems. A failure to recognise and support these linkages results in a fragmented system where valuable knowledge fails to translate into innovation, and innovation fails to translate into economic and societal impact.

Ecosystem orchestration

Innovation ecosystems do not thrive on serendipity alone; they require deliberate, skilful coordination, a function generally referred to as orchestration. The orchestrator – which can be a hub firm, a consortium, a non-profit entity, or a government agency – is not a commander but a coordinator, facilitating collaboration, aligning goals, and ensuring the smooth flow of knowledge and resources among independent actors. Effective orchestration is the key to unlocking the collective potential of the network and preventing the fragmentation that plagues many innovation ecosystems.

This paper identifies three primary orchestration styles, each suited to different contexts:

1. **Directive orchestration**: Characterised by strong central control, where a dominant actor (e.g. a large multinational) selectively engages partners to achieve its strategic objectives. This model is efficient for targeted, mission-oriented projects but can stifle broader, emergent innovation.
2. **Collaborative orchestration**: A decentralised, non-hierarchical approach that fosters open co-construction and knowledge sharing among peers. This style, often seen in living labs and open innovation platforms, excels at generating novel ideas but may lack a clear commercialisation pathway as divergent interests among actors may hinder the efficiency to capitalise on opportunities.
3. **Hybrid orchestration**: A flexible blend of the two, often starting with a directive approach to establish a framework and mobilise resources, then transitioning to a more collaborative mode to foster co-creation and long-term engagement. This adaptive style is often the most effective in complex, evolving ecosystems.

Regardless of the style, successful orchestration involves executing three core processes:

1. **Encouraging knowledge mobility**: Actively facilitating the exchange, absorption, and transfer of knowledge between academia and industry, and across firms. This involves creating shared platforms, fostering a common identity, and strengthening inter-organisational interactions.
2. **Ensuring fair appropriability**: Establishing transparent governance and rules to ensure the value generated is distributed equitably among all contributors. This

prevents opportunistic behaviour and builds the trust necessary for long term collaboration.

3. **Strengthening network stability and resilience**: Maintaining the ecosystem's attractiveness and cohesion by cultivating a shared long-term vision and promoting diverse, multi-layered interactions among actors, enabling the network to adapt to external shocks.

Processes and practices

Within an orchestrated framework, innovation is driven by the dynamic interplay of processes and practices. Successfully orchestrating an ecosystem requires a paradigm shift away from traditional, firm-centric models of operation.

- **Processes** are the structured, systematic, goal-oriented workflows that guide innovation from idea to results. Critically, these are not the somewhat linear, predictable sequences of firm-centric models. Instead, innovation processes in an ecosystem often resemble a 'social spaghetti' of complex, interactive knowledge flows that guide iterations. This reality demands that strategic management tools, like technology roadmaps, be fundamentally reconceived for the ecosystem level. Simply adapting firm-level tools is insufficient; new frameworks are needed to align the strategic visions and resources of multiple, independent actors toward a common goal.

- **Practices** are the informal, culturally embedded behaviours that form the relational fabric of the ecosystem to enable effective collaboration. These are the routines of knowledge sharing, networking, and co-creation that bring formal processes to life. Open innovation events, such as hackathons, are prime examples of structured activities designed to foster these collaborative practices. These practices are underpinned by an organisational and ecosystemic culture that values openness, trust, and a shared commitment to growth. Without this shared culture, even the most well-designed processes will fail to gain traction.

Ultimately, processes and practices are deeply interdependent. A well-designed process provides the structure for collaboration to scale, while a vibrant collaborative culture provides the trust and engagement necessary for any process to succeed. The fusion of these two elements is the true engine of a thriving innovation ecosystem.

The role of public policy: From enabler to catalyst

Public policy is a powerful lever for shaping innovation ecosystems, but its application must be strategic and context-aware, as our analysis indicates that a 'one-size-fits-all' approach is ineffective. Policy must evolve from simply enabling innovation to actively catalysing it, recognising the distinct but complementary roles of entrepreneurial and innovation ecosystems.

Our findings show that a critical area for focus is the need to strengthen the bridge between these two ecosystems, to create a seamless pathway for firms as their needs evolve from incubation to international scaling. This pathway begins with human capital, and this White

paper highlights the necessity of diversifying entrepreneurial education beyond traditional business schools. Successful models, such as the invention to Innovation (i2I) programmes, demonstrate the impact of embedding commercialisation skills directly within Science, technology, engineering and mathematics (STEM) programmes to close the lab-to-market gap. At a broader scale, our analysis indicates that large-scale national programmes, like the Global Innovation Clusters, are most effective when they move beyond funding to adopt a 'global orchestration' mindset, actively fostering collaboration across regions and sectors. This strategic orchestration also involves balancing the proven benefits of territorially anchored ecosystems, such as Quebec's Innovation Zones, with the need for national and international connectivity. Finally, a persistent challenge identified in our research is the fragmented support landscape faced by small and medium-sized enterprises (SMEs), which reveals a clear need to streamline support programmes to better align them with the realities of scaling firms.

The measurement challenge: Moving beyond bean counting

'What gets measured gets done.' Yet, measuring the performance and impact of innovation ecosystems is a formidable challenge. Traditional metrics like patent counts and research and development (R&D) expenditure are insufficient, as they fail to capture the shared value, knowledge spillovers, and network effects that are the true hallmarks of a thriving ecosystem.

Our research indicates that addressing the measurement deficit requires a multifaceted approach that moves beyond single, static metrics. The analysis points to the value of adopting multilayered frameworks, showing that an effective strategy combines a logical framework for planning and monitoring with a retrospective Impact Measurement Framework to evaluate both intended and unintended consequences. Furthermore, the research underscores that for these frameworks to be effective, their performance indicators should be co-designed with ecosystem actors. This collaborative and agile process ensures that metrics remain aligned with shared objectives as the ecosystem matures. Finally, our work demonstrates the significant potential of embracing new data sources and methods to overcome the limitations of traditional surveys. Qualitative methods are crucial for capturing the nuanced, indirect benefits of collaboration. Novel approaches, such as using Natural Language Processing (NLP) on web-based data, can offer real-time insights and capture the nuanced, indirect benefits of collaboration that are often missed.

To overcome chronic data fragmentation in Canada, we propose two key interrelated structural solutions:

1. **Innovation observatory:** An interdisciplinary, cross-jurisdictional innovation observatory to help centralise collected data and coordinate its collection, to develop, test and standardise world-class indicators, and to contribute to providing the strategic intelligence necessary for evidence-based policymaking.
2. **Research institute:** An intersectoral and interdisciplinary research institute dedicated to mapping existing, missing, and needed data to support strategic intelligence programmes, as recommended by the OECD. Its role would be to evaluate the impact of public policies on innovation and growth while tailoring

approaches to the Canadian context. Bringing together academia, government, and organisations supporting business innovation, the institute would serve as a hub for evidence-based policy and practice.

Conclusion

Fostering a world class innovation economy is not about picking winners nor simply funding research; it is about cultivating the rich, fertile soil of interconnected ecosystems to enable Canada to transform its scientific and technological strengths into innovation and economic and social impact. This will require a sophisticated understanding of the distinct roles of knowledge, entrepreneurship, innovation, and business ecosystems and the active, skilful orchestration that binds them together. It demands that firms adopt open, collaborative practices and that governments design agile, aligned, evidence-based policies.

The recommendations outlined in this summary provide a roadmap for action. For ecosystem orchestrators, the priority is to master the art of adaptive coordination and value sharing. For business leaders, the priority is to embrace ecosystemic collaboration as a core strategic imperative. And for policymakers, the challenge is to move beyond siloed programmes and towards becoming a 'global orchestrator' of a truly national innovation system – one that is connected, resilient, and capable of turning Canada's profound S&T strengths into sustainable prosperity for all. Our recommendations give Canada a clear direction. If we act now, our science may translate into lasting impact. If we wait, our ideas might only benefit others and create value elsewhere.

Recommendations

This white paper proposes several recommendations, as well as avenues for further research that will help address some of the questions they raise. Each of the chapters presents the foundational phenomena that lead to the recommendations.

1 – Learn what an innovation ecosystem actually is (and what it isn't)

For Innovation Ecosystem Orchestrators

2.1 – Develop an exhaustive and dynamic mapping of ecosystem members
2.2 – Orchestrate the ecosystem you have
2.3 – Constantly review and improve the orchestration of the ecosystem to ensure resilience
2.4 – Ensure equitable access to knowledge and fair sharing of the value created
2.5 – Take into account the characteristics, offerings, needs and demands of surrounding ecosystems

For Organisations within Innovation Ecosystems

3.1 – Encourage the updating of strategic management frameworks to design innovation processes that are more aligned with ecosystem collaboration
3.2 – Equip ecosystems with tools for strategic ecosystem management
3.3 – Invest in programmes that promote and encourage the adoption of an entrepreneurial culture

3.4 – Invest in collaboration practices that work, including the creation of dedicated roles to support their deployment
3.5 – Identify and mobilise actors who are motivated and capable of driving adoption to completion

For Policymakers

4.1 – Strengthen the links between innovation ecosystems and entrepreneurial ecosystems, and recognise the role of each
4.2 – Broaden the diversity of entrepreneurial training offered across the university network
4.3 – Ensure a balance between the territorial anchoring of innovation ecosystems and their regional and national reach in innovation policy development
4.4 – Better align innovation policies with the needs of SMEs
4.5 – Reduce the number and complexity of growth and innovation support applications as well as the data required

For Policymakers, Orchestrators, and Research and Innovation Intermediaries

5.1 – Co-develop the policies, programmes, measurement frameworks and underlying indicators at the same time
5.2 – Establish the connections between the various indicators
5.3 – Establish a world class data collection and indicator analysis system within an innovation observatory
5.4 – Create an intersectoral and interdisciplinary research institute for innovation

Chapter 1
Innovation Ecosystems

Catherine Beaudry

> An innovation ecosystem is a coevolving network of actors, whose activities and outcomes aim to create value from innovation through their diverse formal and informal interactions.
> — Catherine Beaudry

What are innovation ecosystems?

Ecosystem actors comprise a wide variety of actors: various corporations, including small and medium-sized enterprises (SMEs) and large firms, higher education institutions, universities and other research organisations (ROs), research and innovation intermediaries, government policymakers and regulators, investors (e.g. banks and venture capitalists), as well as end-users. These stakeholders interact through non-hierarchical relationships, building on their multilateral complementarities and fostering continuous evolution and performance for their members, as well as for the ecosystem itself.

> 'In Canada, we have a very robust technology ecosystem, with universities and research centres like IVADO, incubators and organizations like Bonjour Startup Montréal, among the best in the world. It also benefits from a vast pool of talented researchers and entrepreneurs. Venture capital supports this ecosystem by fostering the development of innovative companies offering new products, services or ways of doing things.'
> — Thomas Park, Vice-president, Operational support and strategy, BDC Capital (24 February 2021) *Être ou ne pas être une licorne?* [Webinar] www.4point0.ca/s/1674

Activities undertaken and co-organised within innovation ecosystems range from individual or collaborative research and development (R&D) to generating and sharing intellectual property, providing collective learning opportunities to orchestrating the innovation ecosystem. Organising networking opportunities and other collaborative events is a key mission that ensures ecosystem cohesion. Knowledge sharing among ecosystem stakeholders contributes to accelerating innovation.

> 'The keystone of an innovation ecosystem lies in the expression and recognition by all stakeholders of a common purpose – a shared raison d'être – which justifies a form of solidarity commitment to share knowledge, pool skills, and explore new solutions together to ensure the perpetuation of a common future.'
> — Patrick Cohendet (p. 141)[1]

Ecosystem outcomes comprise all building blocks for innovation, such as knowledge, intellectual property (e.g. patents), technologies, and physical products. The main goal of the innovation ecosystem is to co-create more value for its stakeholders collectively than

individual players could achieve on their own. By fostering collective learning, facilitating the diffusion of new technologies, they centre on creating value by developing new products, processes or services. Innovation ecosystems are rooted in, yet differ from, the concept of business ecosystems[a] whose focus is value capture and competitive advantage.

Among the many definitions of innovation ecosystems[b] proposed over the years, that of Ove Granstrand and Marcus Holgersson [2] is one of our main inspirations.

> 'An innovation ecosystem is the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors.'
> — Ove Granstrand & Marcus Holgersson (p. 1)[2]

They observed that while collaboration is always present in definitions of innovation ecosystems, competition is often left out, or relegated to the realm of business ecosystems. Yet, as highlighted by Leonardo Augusto de Vasconcelos Gomes et al.,[3] relationships between actors of an ecosystem are ever evolving, often moving from cooperation to competition and vice versa.

> 'The relationships among [innovation ecosystem] actors are unstable and unclear, co-evolving in unforeseen ways, which may be changing from cooperation to competition.'
> — Leonardo Augusto de Vasconcelos Gomes, Ana Lucia Figueiredo Facin, Mario Sergio Salerno, & Rodrigo Kazuo Ikenami (p. 46)[3]

How to orchestrate innovation ecosystems

Innovation ecosystems can grow naturally, but they can also be guided to grow through deliberate efforts; this is generally known as 'orchestration'. As old habits die hard', innovation 'orchestrators' need to actively work at maintaining a collaborative spirit and preventing the development of an extremely competitive atmosphere. Orchestration thus refers to a series of activities aimed at developing, managing, and coordinating the different players within an innovation ecosystem to foster collaboration, create value, and ensure smooth interactions. Some also refer to this as 'ecosystem governance' or even 'choreography', highlighting the structured yet flexible nature of the process.

Unlike traditional top-down management, orchestration is more about facilitating cooperation among independent players, each with their own interests. A central entity – often called the 'hub firm' – typically takes on this role. However, orchestration is not limited to a single company; it can also be led by a group of organisations, research teams, or even non-profits.

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[a] Business ecosystems were first proposed by Michael Rothschild in 1990 and James Moore in 1993. See Annex A for more details.

[b] The term 'ecosystem' has become prevalent in both academic and practical domains of economics, management, and policy. It has gradually replaced other terms such as districts, clusters, and national and regional innovation systems. More information on these precursor concepts is provided in Annex A.

Since innovation ecosystems involve a wide range of participants, coordinating them can be complex. The orchestrator helps align goals, reduce conflicts, and ensure everyone contributes to and benefits from the ecosystem. By doing so, it helps create and capture value while maintaining a balance between collaboration and competition.

> The danger is that too many organisations seem to want to orchestrate the innovation ecosystem. The result is an orchestra with 20 musician-wannabe-maestros jostling for the conductor position, leaving no trumpets or percussionists, half of the first violin section and only one French horn – not a set up that makes for great music. To make great music, the maestro must work collectively with the principal or section heads and involve all of the musicians in the co-construction of the performance. The same goes for innovation ecosystems.
> — Catherine Beaudry

Connected ecosystems

This white paper focuses on the relationships between innovation ecosystems and three other ecosystem types: knowledge, entrepreneurship, and business ecosystems (see Figure 1-1 for their interrelations).[c]

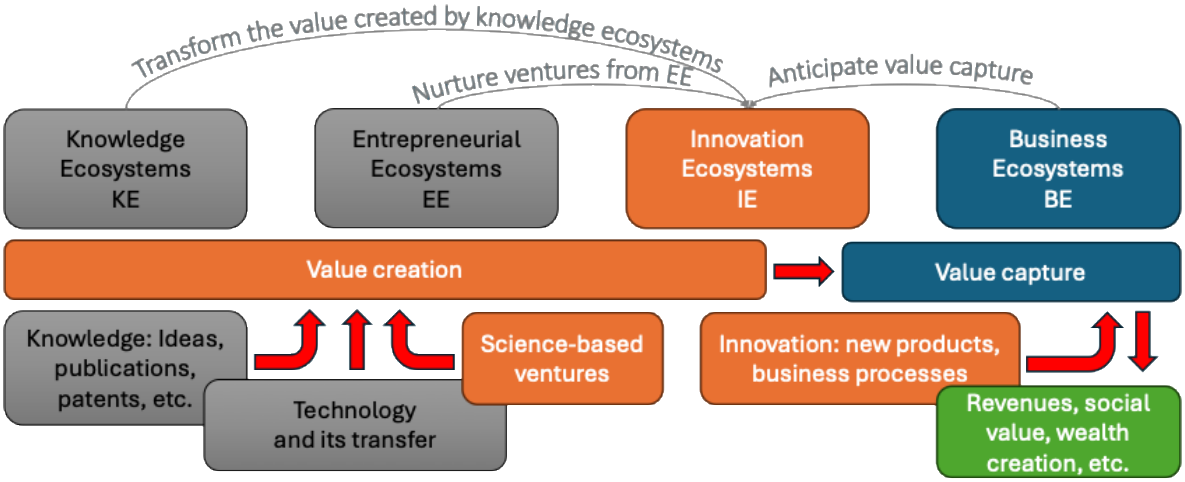

Figure 1-1 – Ecosystem characteristics and interrelations
Knowledge ecosystems generate value through knowledge creation, innovation ecosystems leverage this knowledge to create value, entrepreneurial ecosystems focus on creating value via new ventures, and business ecosystems capture the value created from innovation.

Knowledge ecosystems concentrate on the creation and sharing of knowledge, especially in early-stage, pre-competitive environments. Universities, public research institutions, and other knowledge-intensive organisations play a key role in these ecosystems, prioritising fundamental research and development of technology. Unlike business and innovation ecosystems, knowledge ecosystems focus on generating ideas that may later lead to new technologies, business models, or industries. The interaction between these ecosystems

[c] See Annex A for a very brief review of the concepts.

highlights the complex, multilayered nature of modern innovation, where basic research gradually evolves into applied research, technology, and commercial opportunities.

> ‘Before leading to innovation, there has probably been scientific work developed in collaboration, for example, through joint projects involving university researchers and companies. In addition, intellectual property has probably been created, whether public or strategic, and is therefore protected by secrecy.’
> — Catherine Beaudry (10 April 2024) *Nos PME pour le déploiement de stratégies d’éco-innovation* [Webinar]
> www.4point0.ca/s/6431

Entrepreneurial ecosystems are closely related to knowledge and innovation ecosystems. Ecosystem components and the local context significantly influence the choices and decisions of entrepreneurs. Entrepreneurial ecosystems strive to establish conducive environments that foster the emergence of new businesses and rapid growth companies, encompassing the establishment of innovative start-ups and the expansion of existing businesses.

Business ecosystems are networks of different organisations that co-evolve by interacting around a central company. While they may compete in some areas, they also collaborate to create value that no single company could achieve alone. These ecosystems go beyond traditional industry limits, bringing together firms from different sectors that offer complementary skills and resources. The main goal of a business ecosystem is to help companies strengthen their competitive advantage while adapting to changes in the economy.

> ‘Whereas the notion of [a] business ecosystem construct is generally used to analyse how a given organisation manages to capture value, notably by orchestrating its interactions with various stakeholders, an innovation ecosystem shifts the focus to the issue of value creation by analysing how a structure of heterogeneous actors engaged in a process of knowledge and insight exchange, acts on its environment, develops new solutions, and co-creates value.’
> — Catherine Beaudry, Thierry Burger-Helmchen, & Patrick Cohendet (p. 537)[4]

Is the distinction important?

Firms that operate within these ecosystems may not see these distinctions as particularly relevant; they generally talk about their ecosystem without specifically referring to a type. However, for policymakers, especially those responsible for creating science, technology and innovation (STI) policies, these distinctions are crucial for effectively targeting their interventions and measuring their impact.

Because the same players are involved across several ecosystems, their roles change slightly within each ecosystem (see Figure 1-2 for a schematic representation of these multiple associations). For instance, businesses engage in knowledge ecosystems through university–industry partnerships, consulting agreements, and various research alliances and partnerships. Governments support both academic and corporate R&D through funding. However, researchers and their institutions or organisations are the key players.

> ‘The strength of the aerospace innovation ecosystem stems from the great fortune we have in Quebec of having a very dense ecosystem with very close links between researchers and industrial specialists.’
> — Alain Aubertin, ex-CEO of CRIAQ (4 May 2020) *Écosystème de l’aérospatiale* [Webinar]
> www.4point0.ca/s/1264

Conversely, business ecosystems are undoubtedly where firms dominate, with all other participants contributing to the value capture objective. The interrelations between different types of organisations within these ecosystems, however, are not as straightforward and are greatly influenced by several factors.

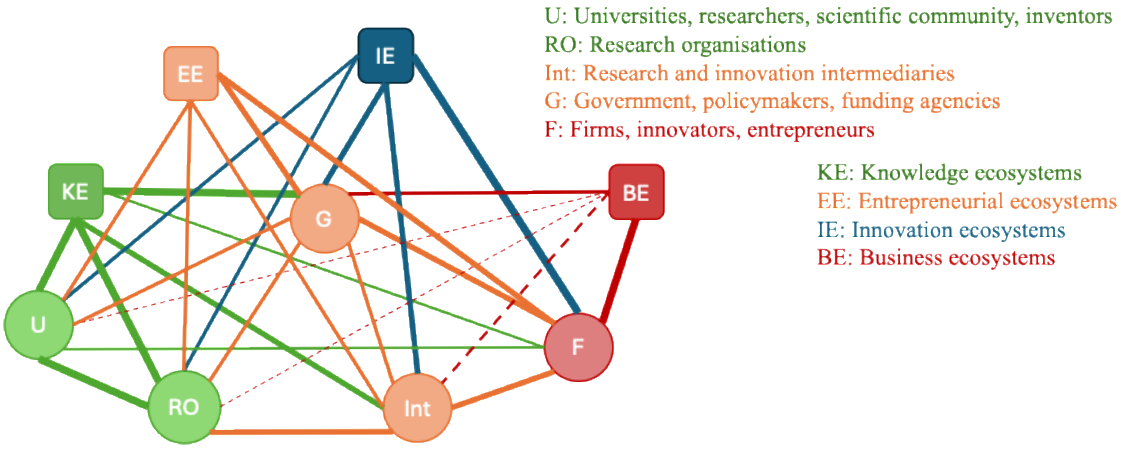

Figure 1-2 – Links between ecosystem stakeholders
With stakeholder roles that range from S&T to facilitation and acceleration of innovation impact, innovation ecosystems are confronted with a complex web of interrelations.

Innovation ecosystems as ‘global orchestrators’

Orchestrating an innovation ecosystem while taking into account the multiple relationships of stakeholders outside this ecosystem is anything but trivial. Innovation ecosystem orchestrators must be aware of knowledge ecosystems and leverage their outcomes, as well as integrating the new ventures that stem from the entrepreneurial ecosystems to create value. They should do so while anticipating how the stakeholders of business ecosystems will capture the value created. Not only do they need to orchestrate their own innovation ecosystem, but they must also plan and coordinate with members of other ecosystems and of other types of ecosystems.

> The orchestrator entity, or the group of organisations acting as orchestrator, must therefore understand and integrate what comes out of knowledge ecosystems and entrepreneurial ecosystems, and anticipate the value capture that must take place within business ecosystems so as to plan the value creation that occurs within innovation ecosystems. They must also be aware of other ecosystems’ value creation. This could be portrayed as a ‘global orchestrator’ role.
> — Catherine Beaudry

In their role as ‘global orchestrators’, bridging knowledge, entrepreneurial, and business ecosystems, innovation ecosystems are key to linking science and technology (S&T) to innovation and its impact.

> ‘It’s all about culture: an entrepreneurial culture, a culture of innovation, a culture of growth and a culture of internationalisation. So I think that if one day we aspire to achieve higher positions in international rankings, it is essential to take the time to build this culture in our region.’
> — Sophie Veilleux (24 February 2021) *Être ou ne pas être une licorne?* [Webinar]
> www.4point0.ca/s/1674

Scope and objectives of this white paper

This white paper first presents the various activities, strategies, practices and processes undertaken by the stakeholders and ecosystem orchestrators to foster and benefit from the synergies therein. It then addresses the role of public policies and programs to support such coordinating activities. Because firms, governments and ecosystem orchestrators must evaluate their performance and the impact of their activities, the last chapter addresses the challenges posed by measuring appropriate indicators. The white paper concludes with a series of recommendations deriving from the research performed by 4POINT0.

Chapter 2
Innovation Ecosystem Orchestration

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> 'The orchestrator has the ability to navigate between the business and knowledge ecosystems, playing a crucial role in the redistribution of capabilities, knowledge and all services. As a fundamental element of the ecosystem, its importance cannot be underestimated. To date, some ecosystems have not yet fully embraced this important role in ensuring that value creation is generated and redistributed.'
> — Annie Passalacqua (23 February 2023) *Cartographie des écosystèmes d'innovation en santé: démarche et recommandations pour les intermédiaires d'innovation* [Webinar]
> www.4point0.ca/s/3639

Introduction

As mentioned in the previous chapter, orchestration is a method for effectively managing the interconnected components of an innovation ecosystem. In practice, orchestrating an innovation ecosystem consists of strategically aligning the interests and activities of various actors in order to maximise value creation for everyone. Unlike traditional management methods based on a strong hierarchy, orchestration is based on coordinated initiatives led by a central organisation called the 'orchestrator'. The orchestrator plays a dual role: stimulating cooperation to create collective or shared value while enabling partners to achieve individual benefits. The orchestrator is crucial to ensuring the cohesion of the ecosystem, preventing opportunistic behaviour and ensuring that all actors' efforts converge effectively towards the set objectives.

While orchestration is generally carried out by a leading company, it can also be undertaken by a variety of organisations such as consortia, academic networks or not-for-profit organisations, depending on the context and objectives of each ecosystem. Each has its own orchestration style that is adapted to the innovation ecosystem to be coordinated.

> 'Innovation ecosystems are not controlled by one large focal firm, but activities in an ecosystem centre around the firm, activity, or technology that influences an ecosystem's responses to externalities and its evolution.'
> — Nasrin Sultana, Ekaterina Turkina, & Patrick Cohendet (p. 1448)[5]

The coordination activities undertaken by the consortium for the Evolution of Networked Services through a Corridor in Quebec and Ontario for Research and Innovation, namely the ENCQOR 5G programme, illustrate how a group of organisations acts as an orchestrator, mobilising key actors to facilitate the emergence of an innovation ecosystem in the fifth generation of mobile telecommunication. Unlike the traditional model where a firm takes the lead, ENCQOR 5G brought together several key players of the ecosystem, including multinational corporations (Ericsson, Ciena, Thales, IBM, CGI), government agencies (federal, and the provincial governments of Ontario and Quebec), and innovation intermediaries (PROMPT, ADRIQ). By bringing together these influential stakeholders, ENCQOR 5G established the legitimacy needed to orchestrate the ecosystem, structuring collaborations, setting up governance mechanisms, and ensuring resource flows between participants. A detailed analysis of ENCQOR 5G orchestration processes is provided below (see Box **2-2**).

This chapter first describes different methods to map innovation ecosystems. It then explores various types of orchestration, the orchestration process, and roles. Lastly, the chapter addresses the 'global orchestration' alluded to in the previous chapter.

Mapping ecosystems: A critical step for orchestrators

The act of orchestration requires a deep understanding of the ecosystem, its key actors, and their relationships, in order to effectively assess its structure and dynamics. Mapping the ecosystem empowers orchestrators to identify actors and stakeholders, as well as their roles and interdependencies, enabling strategic resource allocation and collaboration. Understanding the intricacies of an ecosystem is crucial for aligning incentives, fostering partnerships, and implementing governance mechanisms to drive innovation. Ultimately, ecosystem mapping enables orchestrators to effectively coordinate efforts, navigate uncertainties, and ensure the ecosystem's long-term success.

Each actor of an innovation ecosystem plays a specific role in the value chain. As highlighted by Ove Granstrand and Marcus Holgersson,[2] the performance of an innovation ecosystem is not solely determined by the contributions of individual stakeholders but is fundamentally shaped by the synergies and mechanisms that facilitate collaboration, knowledge exchange, and resource sharing among them. A clear mapping of the actors and their roles is necessary to correctly orchestrate the ecosystem, to define appropriate performance indicators,[6] and to assess the ecosystem's overall value creation and impact[d].

The mapping process provides a visual representation of relationships and a structural analysis of interactions within the ecosystem. It helps identify discontinuities in value chains, collaboration opportunities, and areas for improvement within the ecosystem.[7]

Before beginning to map an ecosystem, it is essential to clearly define its scope and objectives. For Yuzhuo Cai,[8] establishing clear boundaries ensures that the analysis remains focused and relevant. A well-defined scope prevents overgeneralisation and guides

[d] Chapter 5 explores impact measurement in greater detail.

selection of the right data sources and mapping methods. Understanding and analysing an innovation ecosystem requires structured mapping techniques that highlight key relationships, value flows, and structural dynamics. Depending on the objective, mapping an ecosystem offers a unique lens for:

- Identifying key actors and their interconnections to understand how the ecosystem is structured;[9]
- Understanding governance structures and knowledge flows to assess how decision-making occurs;[8]
- Detecting areas of synergy and collaboration gaps that may affect collective action;[10]
- Uncovering strategic action levers that can strengthen ecosystem cohesion and optimise resource allocation.[7]

Far from being a static representation, an ecosystem mapping reflects both the current state and the ongoing evolution of an ecosystem. It allows stakeholders to track progress and adapt their strategies over time. To leverage ecosystem mapping as an analytical tool and to effectively analyse an innovation ecosystem, different types of mapping techniques can be used. Here are some of the most relevant mapping methods:

1. **Hierarchical mapping** – This approach structures relationships in a tiered format, illustrating different levels of influence and dependencies among actors;[11]
2. **System dynamics mapping** – A system dynamics map represents an ecosystem as an interconnected network, showcasing how different components interact within a process;[12]
3. **Flowchart mapping** – Flowcharts illustrate step-by-step sequences of actions, decisions or interactions (see Figure 2-1);[13]
4. **Ecosystem pie model** (EPM) – The EPM model is particularly effective for examining how value is created, distributed, and shared within an ecosystem. It identifies the contributions of different stakeholders and the possible combinations of value creation, helping organisations to position themselves strategically (see Figure 2-2);[7]

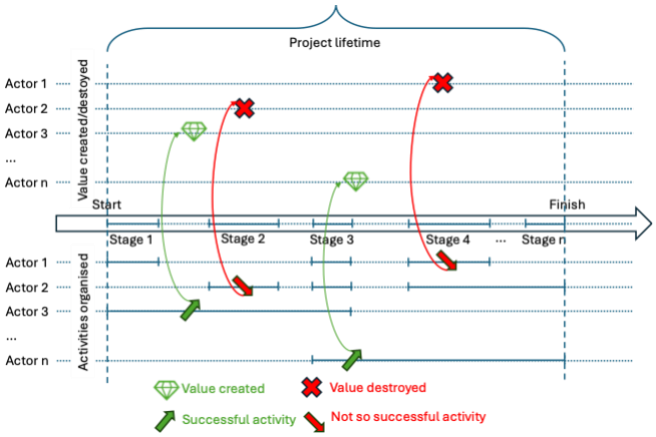

Figure 2-1 – Schematic example of a flow chart

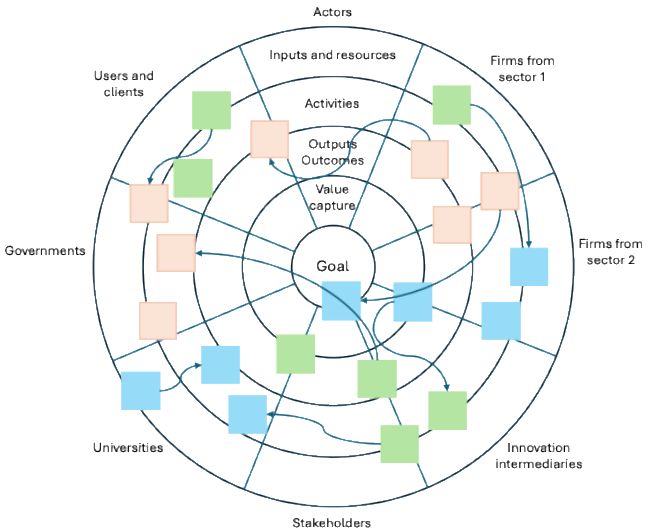

Figure 2-2 – Schematic example of an EPM

5. **Social network analysis** (SNA) – SNA focuses on mapping relationships between individuals, organisations, or groups based on their interactions and influence (see Figure 2-3). It helps reveal key influencers, communication gaps, and clusters within an ecosystem. This method is particularly useful for analysing the strength of collaborations, the diffusion of knowledge, and the emergence of innovation hubs.[9] 4POINT0 members Nasrin Sultana, Ekaterina Turkina and Patrick Cohendet,[5] for instance, mapped the evolution of the Montreal artificial intelligence ecosystem from its emergence.

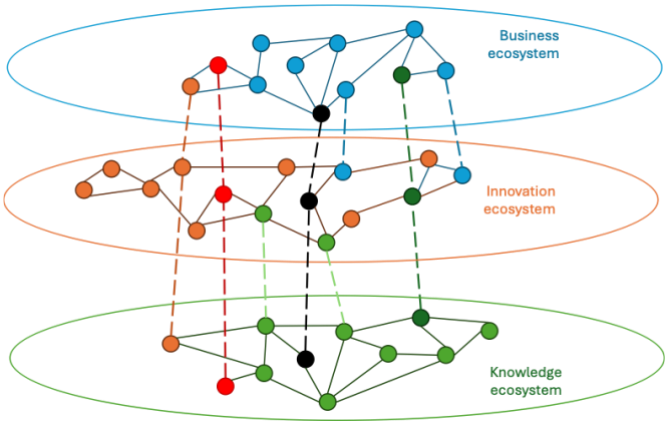

Figure 2-3 – Schematic example of a social network

> 'Network analysis is a common way to examine innovation ecosystems. […] Connectedness is the extent to which different companies in the same region and industry are linked to the same stakeholders.'
> — Jan Youtie, Robert Ward, Philip Shapira, Sandra R. Schillo, & Louise E. Earl (pp. 258-259)[14]

Each of these mapping methods serves a specific purpose and can be used independently or in combination to gain a comprehensive understanding of an ecosystem's structure. Selecting the right approach depends on the objectives of the analysis and the specific insights needed for performance measurement. Ecosystem mapping goes beyond simply documenting relationships. It is a strategic framework for guiding innovation and decision-making. By identifying synergies, weaknesses, and opportunities, it serves as a powerful tool for policymakers, industry leaders, and intermediaries looking to optimise ecosystem performance.

> 'The different models [for mapping innovation ecosystems] are not just maps with organisational logos. I think we can really allow ourselves to dig deeper into the dimensions, into the processes, and then into the relationships.'
> — Annie Passalacqua (23 February 2023) *Cartographie des écosystèmes d'innovation en santé: démarche et recommandations pour les intermédiaires d'innovation* [Webinar]
> www.4point0.ca/s/3639

> 'Mapping an ecosystem can help to identify the components and the relationships amongst the players, provide a holistic view of the system, examine the behavior pattern and impact mechanism, as well as monitor its evolutionary trends'
> — Guannan Xu, Weijie Hu, Yuanyuan Qiao, & Yuan Zhou (p. 2057)[9]

Different types of orchestration

The orchestrator can adopt different modes of intervention, each structured to meet the specific needs of the ecosystem. Three main orchestration styles are described below: directive, collaborative, and hybrid. These approaches illustrate the flexibility and adaptability of the orchestration role.

Directive orchestration

In a directive orchestration, the orchestrator exercises strong control over the resources and players in the ecosystem. Members are admitted selectively, based on their direct contribution to the orchestrator's strategic objectives, which are often geared towards immediate competitive advantage.

The examples of IBM and Boeing, explored by Satish Nambisan and Mohanbir Sawhney,[15] provide a good illustration of this directive logic. Both multinational companies will likely play an important role in three Quebec Innovation Zones: IBM in both DistriQ, a quantum innovation zone in Sherbrooke, and Technum Québec in Bromont, and Boeing, a star player in EspaceAéro, a multi-site aerospace innovation zone in Greater Montreal.

Thanks to its large portfolio of patents, IBM has positioned itself as a key player in its innovation ecosystem. These patents are a strategic resource that IBM uses to attract and select precisely the partners capable of strengthening its competitive position. Access to these patents is conditional on collaboration aligned with the commercial and technological objectives defined by IBM. Boeing adopted a similar directive orchestration style in the 787 project network. Despite the relative autonomy granted to each partner for the design of individual components, Boeing maintains rigorous centralised control over final integration. This centralisation allows Boeing to strategically steer the entire project, ensuring the technological coherence of the modules developed by its partners, while maximising its own competitive advantage. Understanding how these directive orchestration styles will impact Quebec's Innovation Zones is highly relevant.

Collaborative orchestration

By opting for collaborative orchestration, the orchestrator favours a decentralised dynamic that encourages fluid, non-hierarchical interactions between ecosystem members. In this model, the emphasis is on co-construction and open dissemination of knowledge, guided by collective objectives that extend beyond individual ambitions.

This type of orchestration requires a strong relational position of neutrality and integrity, to allow the orchestrator to act as an intermediary to facilitate exchanges. The non-competitive orientation that characterises this approach encourages sincere and equitable collaboration between the players. Unlike directive orchestration, where a central actor imposes structure and control, collaborative orchestration is based on openness, shared decision-making, and facilitation rather than authority.

> 'In the field of healthcare innovation, intermediation refers to organisations and processes that facilitate collaboration between different players in the ecosystem, such as researchers, healthcare providers, technology

> companies and patients. These intermediaries help to bridge gaps in communication, understanding and cooperation to accelerate the development and implementation of healthcare innovations.'
> — Nicolas Sacchetti [16]

The Living Lab model, studied by Nathalie Tremblay et al.,[17] illustrates this approach. Their research on the TransMedTech Institute (iTMT) highlights how it acts as an innovation facilitator, bringing together diverse stakeholders such as clinicians, patients, researchers, and industry partners, to collectively develop and refine new technologies. Instead of dictating outcomes, iTMT creates a collaborative space for experimentation and problem solving, ensuring that innovations align with real-world needs. This model demonstrates how living labs enable collaborative orchestration by promoting inclusive participation, knowledge exchange, and shared decision-making, rather than relying on a single directive orchestrator. Kathy Malas stressed that 'complex problems such as COVID-19 cannot be solved by a single organisation, […] cross-sectoral collaboration is a priority'.[e] The Innovator in Residence programme is another example of activities designed to encourage interactions and collaborative innovation within the ecosystem.

Hybrid orchestration

The hybrid approach is characterised by the orchestrator's ability to combine the advantages of centralised governance with those of decentralised management, supporting optimal adaptation to the demands of innovation.

For example, when launching a project, the orchestrator can establish a rigorous framework that defines clear objectives and selectively mobilises resources. This directive approach, based on both relational and financial strengths, enables individual contributions to be directed effectively while promoting collective benefits. Over time, this approach evolves towards a gradual openness, encouraging co-creation and the involvement of all actors in the ecosystem. Quebec's transport electrification strategy exemplifies hybrid orchestration: Hydro-Québec's directive, government-backed build-out of charging infrastructure is intended to seed the market and progressively shift governance toward a more collaborative, market-led ecosystem, while Hydro-Québec retains an influential role (see Box 2-1). The aim of this transition is to establish a sustainable collaborative dynamic, in which the initial strategic vision is enriched by the creative contributions of the members, with a view to long-term added value.

> Hybrid orchestration is all about flexibility – you can't just impose a structure every time, but you also can't leave everything open-ended and expect results. Sometimes, you need clear direction to get things moving, especially at the start when roles and goals aren't yet defined. But as things progress, you have to step back, let collaboration take over, and create space for innovation. It's not just about choosing between control and openness; it's also about knowing when to switch and how to balance both at the same time. That's what keeps ecosystems dynamic instead of either

[e] https://www.4point0.ca/2023/06/02/linnovation-au-coeur-de-la-gestion-de-la-pandemie-en-covid-19-en-sante/

> rigid or chaotic.
> — Anas Ramdani

In most innovation ecosystems, a hybrid approach that rapidly transitions to a collaborative mode is likely to be the most efficient. For instance, Rhonda O'Keefe explains how Ngen's empowerment approach helps companies by 'making sure that the companies are ready to put in the effort, that they apply the various strategies identified to complete the project, and that they can manage the economic and technical risks involved.'[18]

Although hybrid orchestration may be directive in part, it should account for the fact that members of innovation ecosystems are not only stakeholders but actors, as highlighted by Giulia Piantoni et al. in the excerpt below. As such, they are not merely bystanders but active participants, likely to contribute more to the orchestration, whether directly or indirectly.

> 'An IE is, by definition, constituted of interdependent and independent actors that have a proactive role in its construction and development and contribute in different ways to the SV creation process with their resources, capabilities, relations and complementarities. […] As such, these "actors" are not simply "stakeholders", traditionally seen as entities with stake or interests, in a company's activities: actors of an IE are recognised as proactive in creating value and thus their needs, aims and resources are [all] considered […] fundamental to be tackled.'
> — Giulia Piantoni, Laura Dell'Agostino, Marika Arena, & Giovanni Azzone (p. 191)[19]

The orchestration process

Orchestration is based on the implementation of specific processes, each grouping several precise activities. According to Charles Dhanaraj and Arvind Parkhe,[20] this role involves knowledge mobility, equitable appropriation of innovation, and network stability. These key processes are broken down into concrete activities which, depending on how they are implemented by the orchestrator, define the specific roles it assumes in the overall governance of the ecosystem.

It is important to understand this orchestration process in order to either break down silos within the ecosystem (and potentially between ecosystems, as this white paper argues below) or build communities of organisations that share similar needs and can, together, benefit from the value created. As Passalacqua stressed: 'This allows business models to evolve and the ecosystem to grow'.[f]

> 'We have everything we need for international collaboration between manufacturers, with ecosystems, with academic input. To redefine the future of our industry, [it] will become even more necessary to add elements that we have not called on much until now: SMEs and start-ups, for example. SMEs, because with the digital transformation of their activities, [they] are less and less dependent on the locomotives of the major aeronautical manufacturers, can propose solutions to engage, for example, the passenger in a mobility experience that is commensurate with expectations. These passengers and start-ups have a capacity for radical and even disruptive innovation that we're going to have to tame in

[f] https://www.4point0.ca/2023/02/16/projets-cartographie-ecosystemes-innovation-sante/

the aviation industry'.
— Philippe Molaret, ex-CTO of Thales (4 May 2020) *Écosystème de l'aérospatiale* [Webinar]
www.4point0.ca/s/1264

Encouraging knowledge mobility

The orchestrator is a key player in the ecosystem, facilitating the exchange, acquisition, and use of knowledge among its various participants. To achieve this, it employs three main strategies described by Charles Dhanaraj and Arvind Parkhe.[20]

Knowledge absorption and transfer

The orchestrator connects academia and business, facilitating collaboration and preventing innovation from being isolated. It bridges the gap between these two worlds, promoting innovation and knowledge exchange. For example, creating shared platforms that make patents and research results accessible to start-ups and SMEs speeds up knowledge transfer, benefitting all stakeholders.

Cohendet also argues for the importance of fostering a creative environment within ecosystems, so that actors can use knowledge effectively. As such, creativity is a pillar of successful innovation ecosystems, as also highlighted by Elke Schuessler, Silviya Svejenova and Patrick Cohendet.[21] Their work reframes creativity as an organising process deeply embedded in economic and institutional contexts. Practices such as continuous feedback, open conversations, and iterative negotiations among ecosystem members foster shared vision and collaboration. Schuessler et al.[g] also stress the importance of unpacking the 'idea journey,' where contested processes transform nascent ideas into actionable innovations. This relational and context-dependent understanding of creativity complements the structural and technical dimensions of ecosystems, ensuring that they remain adaptive and forward-looking.

Developing an ecosystem identity

To create a unifying identity, the orchestrator actively fosters a sense of belonging among ecosystem participants. It organises regular forums, workshops, and seminars that bring together researchers, business leaders, and entrepreneurs, fostering trust and reinforcing common goals. This aligns with the concept of *middleground* structures developed by Patrick Cohendet, David Grandadam, and Raphaël Suire,[22] which serve as platforms for sustained interaction between organisations and communities. Annie Passalacqua, Patrick Cohendet and Pascal Beauchesne agree that since an ecosystem is based on informal relationships, the orchestrator needs to create spaces for exchange and discussion in order to build relationships by stakeholder and not just by role or practice.

Beyond organising events, Benoit Sarazin, Patrick Cohendet, and Laurent Simon [23] mention that the orchestrator reinforces this identity through the development of a shared manifesto. The manifesto serves as a guiding vision that unites participants under common

[g] To lighten the text, only the first author of these articles will be mentioned in what follows.

principles and objectives, much like how movements in art and science establish their core values. It defines the overarching goals of the ecosystem, ensuring alignment among diverse actors. The manifesto solidifies the ecosystem's identity by embedding a shared purpose and an operational framework that fosters trust and cooperation.

Strengthening interorganisational interactions

The orchestrator promotes collaboration among ecosystem actors through both formal (workshops, seminars) and informal (networking, community-building) interactions. These structured and spontaneous engagements create opportunities for new partnerships and knowledge exchanges. The case of Hacking Health, studied by Karl-Emanuel Dionne, Luc Sirois and Hughes Boulenger,[24] illustrates how structured interactions facilitate spontaneous innovation by organising medical hackathons to foster interdisciplinary cooperation. By enabling frequent touchpoints among ecosystem members, the orchestrator ensures that knowledge circulates freely and that actors are fully integrated into a dynamic, diversified, and interconnected network.

> '[T]he essence of transformational innovation dynamics increasingly lies in the articulation between "formal" actors (firms, research centres, administrative units, etc.) and "informal" actors (lying outside standardized arrangements or commercial settings).'
> — David Grandadam, Patrick Cohendet, & Raphaël Suire (p. 1578)[25]

> 'An ecosystem involves many different types of stakeholders, including start-ups, incubators, accelerators, other support organisations, companies or organisations that provide funding, venture capitalists, universities and government bodies. It's a whole world, and this world really needs to learn how to work together if we are to achieve international clout.'
> — Liette Lamonde, ex-CEO of Prompt (24 February 2021) *Être ou ne pas être une licorne?* [Webinar]
> www.4point0.ca/s/1674

Ensuring fair appropriability of innovation

The orchestrator ensures that the value generated by the innovation is distributed fairly among all the players in the ecosystem. To achieve this goal, the orchestrator implements the three following mechanisms (see article by Dhanaraj and Parkhe [20]).

Preventing opportunistic behaviour

The orchestrator structures the rules and conditions, creating a transparent framework. This reduces the risk of unfair benefit distribution. They ensure fair governance, valuing all contributions, including academic knowledge, financial resources, and technical skills.

> 'All these players need to work in a symbiotic relationship, as opposed to a parasitic one. [...] If there isn't a climate of trust at the root of the innovation zone, it won't work. [...] We have to be careful about the indicators we put in place because we don't want to create parasites, we want [ecosystems] where everyone works in symbiosis [...] so that we don't encourage bad behaviour but [rather] good behaviour that makes it win-win-win for everyone'.
> — Catherine Beaudry (29 January 2020) *Launch of Quebec's Innovation Zones programme*

Implementing fair regulation mechanisms

The orchestrator creates framework cooperation agreements and explicit contracts, ensuring a fair and transparent distribution of financial and non-financial benefits. This encourages long-term commitment from all ecosystem participants (universities, businesses, and entrepreneurs). For example, in large-scale technological collaborations, multinationals may provide access to advanced platforms and technical expertise, while public institutions contribute funding, and innovation hubs offer logistical and administrative support. Clear agreements define how resources – such as infrastructure, funding, and intellectual property – are shared, ensuring that smaller organisations, such as startups and SMEs, have equitable access to experimentation and development opportunities. These mechanisms foster a structured yet flexible environment that sustains engagement from universities, businesses, and entrepreneurs.

Reinforcing the perception of distributive justice

The orchestrator promotes trust and ecosystem unity through transparent distribution of benefits. This fosters a sense of fairness, encouraging active involvement from all stakeholders, including academia, industry, and business. This includes structuring agreements so that no single entity dominates decision-making, and ensuring that all contributors – whether they are large corporations, SMEs, or research institutions – have meaningful roles. For example, ensuring that startups and SMEs can easily access experimentation platforms, that universities can engage in applied research without restrictive conditions, and that industry partners benefit from collaborative synergies without overshadowing smaller players. By fostering a culture of openness and shared governance, the orchestrator reinforces a sense of fairness, encouraging sustained participation from all stakeholders.

Strengthening network stability and resilience

The orchestrator maintains the ecosystem's attractiveness, cohesion and adaptability in the face of external changes. It does so by implementing the three types of strategic initiatives described by Charles Dhanaraj and Arvind Parkhe.[20]

Strengthening the reputation and attractiveness of the ecosystem

The orchestrator boosts the network's reputation by introducing new players with valuable resources and skills. This makes the ecosystem more credible, attracting new members who want to enhance their own legitimacy. This can involve engaging multinational firms that provide access to advanced technologies, attracting government agencies that offer financial support, or incorporating innovation hubs that facilitate experimentation. By fostering collaborations between established industry leaders, research institutions, and startups, the orchestrator signals the ecosystem's legitimacy and potential. As a result, new participants are more inclined to join, seeking both credibility and strategic opportunities. The result is a gradual expansion of the network's partnerships, leading to increased exchange and resource availability.

> ‘Beyond the richness and diversity of its knowledge bases, the power of attraction of an ecosystem can be linked to the effects of “buzz” in a specific industry, “tags” in professional and creative communities, and to the frequency and vibrancy of “events” that renders the density of stimulating knowledge exchange and creation in a specific field and/or territory visible.’
> — Patrick Cohendet (p. 140)[1]

Encouraging long-term vision and shared objectives

The orchestrator builds and maintains a common, shared vision among network players. It fosters a culture of trust, motivating partners to work towards long-term collective benefits. This is achieved by structuring collaborations around common goals, such as advancing technological innovation, facilitating knowledge exchange, or positioning the ecosystem competitively within a global industry. By promoting trust and mutual commitment, the orchestrator aligns the interests of diverse stakeholders – ranging from large corporations to research institutions and SMEs – so that short-term uncertainties do not derail long-term cooperation. This strategic alignment reinforces resilience, allowing the ecosystem to adapt to economic and technological changes while maintaining its collective purpose.

Developing multiple interactions

The orchestrator enhances resilience by promoting diverse interactions among ecosystem actors. It facilitates joint projects, events, and other initiatives, creating robust connections that increase the network’s capacity to handle crises or changes. This approach enhances internal player connections and adapts the ecosystem to external changes, including technology, economics, and geopolitics.

> In a world where technology, economics, and politics are inseparably linked, adaptability is not a luxury – it’s a lifeline. The true strength of an ecosystem isn’t just in its resources but in its ability to evolve, collectively. The more diverse and deeply connected its relationships, the greater its capacity to absorb shocks, recalibrate strategies, and drive sustained innovation.
> — Anas Ramdani

Box 2-1 – The orchestration of the emerging electric vehicle charging ecosystem in Quebec

Quebec’s transport electrification process is designed to meet government-imposed zero-emission vehicle targets (by 2030 at the provincial level and 2035 at the federal level). These regulations require sector-wide compliance while providing industry stakeholders with the confidence needed to invest in critical infrastructure.

Over the years, the Government of Quebec has developed comprehensive strategies for transport electrification, sustainable mobility, and a green economy, introducing various policies and subsidies to strengthen the entire ecosystem. The responsibility for implementing these strategies has been entrusted to Hydro-Québec, a publicly owned company that holds a monopoly on electricity supply in the province.

This section highlights Hydro-Québec's pivotal role as the orchestrator of this emerging ecosystem – an exemplary case of a top-down approach to fostering and establishing an innovation-driven landscape.

'If you build it, they will come'

For Hydro-Québec, the issue is straightforward: for car owners and fleet managers to choose electric vehicles, a reliable charging infrastructure must be in place to support them on the road. However, no private company is likely to invest in an electric vehicle (EV) charging network unless there is a sufficiently large customer base to make it financially viable – the age-old 'chicken-and-egg' dilemma. The strategy conjointly adopted by the provincial government and Hydro-Québec recalls the philosophy of the classic film *Field of Dreams*: 'If you build it, he will come.'

This decision to heavily invest in infrastructure before demand reaches maturity illustrates a deliberate effort to enhance the ecosystem's attractiveness and perceived legitimacy. By taking early and visible action, Hydro-Québec reduced uncertainty for potential partners and demonstrated a strong commitment to the long-term vision. Such moves can initiate momentum and encourage broader participation, creating the conditions for a cohesive and resilient ecosystem to gradually emerge.

To that effect, since 2012, Hydro-Québec created a number of different initiatives and spin-offs to meet this challenge. The first was Electric Circuit, a distinctive initiative within Hydro-Québec, responsible for deploying and managing a network of EV charging stations. Another example is AXSO, a software subsidiary dedicated to the development and management of the Electric Circuit charging network app. To encourage fleet companies to go electric, Hydro-Québec developed solutions under the banner of the subsidiary Cléo, offering customised charging solutions such as management of charging stations and energy optimisation for electric vehicle fleets.

This internal structuring effort reflects an early attempt to build a cohesive ecosystem identity. By clearly assigning complementary roles across infrastructure, software, and services, Hydro-Québec laid the groundwork for coordination among diverse actors. Although these subsidiaries operate within the same organisation, they help create an identity framework that can later support knowledge mobility.

Implementing the strategy: Building the infrastructure and ecosystem at the same time

Using its R&D facilities, Hydro-Québec immediately engaged in the development and procurement of the equipment and services required to deploy the infrastructure, the two main challenges being charging stations and the app for managing the network. As the company lacked some of the required expertise in the field, it engaged in partnerships with companies specialised in technologies of interest for the business. These collaborations illustrate a key mechanism of knowledge mobility: absorbing external expertise to complement internal capabilities and accelerate implementation.

Although its partners played a crucial role, Hydro-Québec has been the driving force behind deployment of the entire infrastructure. With the valuable support of these

partners, Hydro-Québec oversaw the installation of charging stations, developed the mobile app, and managed both operations and customer service for users. The company also took the lead in negotiating with landowners to install charging stations at restaurants, convenience stores, and shopping malls. These businesses, in turn, benefited from the increased foot traffic generated by EV drivers. To maximise these advantages, Hydro-Québec negotiated land-use rights for the charging stations and encouraged drivers to stop by, sometimes integrating promotional deals within the app to create a win-win situation for all stakeholders. These arrangements reflect efforts to ensure fair appropriation by aligning incentives and sharing value among participants. Through negotiated access and promotional tools, Hydro-Québec encouraged mutual benefit while reducing the risk of imbalance between actors.

This large-scale infrastructure deployment had significant ripple effects. Perhaps the most notable is the rapid growth of FLO, a Quebec-based startup launched in 2015 that was already developing charging solutions. Recognising an opportunity to collaborate, FLO leveraged its expertise to work alongside Hydro-Québec. When Hydro-Québec moved into the deployment phase, FLO was the natural choice as a supplier. This partnership provided FLO with a strong foothold in the market that allowed it to rapidly scale. Today, FLO is a leading provider of charging stations, expanding its network across North America.

The future of the EV charging ecosystem and its orchestration

Hydro-Québec has consistently emphasised that it does not seek to maintain control over its subsidiaries, instead focusing on its core competency: energy management. As the infrastructure-in-development becomes financially viable, Hydro-Québec plans to sell these assets to private enterprises, allowing it to concentrate on what it does best: managing the distribution of electricity. In a scenario in which these initiatives are all run by private businesses, with Hydro-Québec as the only supplier of electricity, the orchestration would need to shift to one that is much more horizontal. In that case, the influential position held by Hydro-Québec would remain pivotal for operation of the entire ecosystem.

The ‘build it and they will come’ business strategy is criticised for its optimistic projection. In this case, the assumption is that these EV charging services will eventually become profitable. This is often the issue behind ecosystems initiated by public actors through a top-down approach, as is the case here. Only time will tell whether this approach will be successful, but early signs are emerging. In August 2024, Hydro-Québec announced that its subsidiary Cléo, focused on fleet charging solutions, will be acquired by Polara, a Quebec-based company specialising in transportation electrification. This move reflects Hydro-Québec’s strategy to concentrate on its primary mission, while Polara is expected to drive further growth and expansion for Cléo in providing charging solutions for electric vehicle fleets.

— Fabiano Armellini & Luciana Paula Reis

Orchestration roles

The scientific literature goes into more detail about these roles, identifying specific profiles that can be adopted by the orchestrator, such as architect, facilitator, leader or sponsor (see Table 2-1 for a detailed list of the key activities associated with the different orchestration roles).

Table 2-1 – Orchestration roles

Role	Key activities
Architect	Coordinates strategic priorities and synchronises ecosystem dynamics while integrating key stakeholders within the network.
Auctioneer	Establishes the agenda and cultivates a joint vision to drive alignment and collaboration within the innovation network.
Conductor	Manages the acquisition, transmission, and sharing of information.
Coordinator	Manages interactions among network members to reinforce connections and foster collaboration within the innovation ecosystem.
Developer	Develops tangible and intangible assets for the network by leveraging knowledge mobility.
Facilitator	Brings together diverse actors (including competing actors) to foster collaboration within the innovation ecosystem.
Gatekeeper	Facilitates the extraction and dissemination of knowledge
Judge	Defines the strategic framework and initiates the network
Leader	Motivates and fosters voluntary collaboration, identifies the roles of network members, manages and guides participants toward a shared purpose, and defines contributions and benefits to sustain engagement within the innovation ecosystem.
Link	Serves as an external intermediary, bridging interactions and fostering synergies among network members.
Promoter	Supports ecosystem members in working toward a common goal and actively engages stakeholders in the innovation development process
Representative	Shares insights about the network with external stakeholders while filtering and curating information to ensure relevance and strategic alignment.

Source: Reproduced from Anas Ramdani's doctoral thesis,[26] based on: Minna Pikkarainen, Mari Ervasti, Pia Hurmelinna-Laukkanen, & Satu Nätti;[27] Pia Hurmelinna-Laukkanen & Satu Nätti;[28] and Julhete Mignoni, Bruno Anicet Bittencourt, Silvio Bitencourt da Silva, & Aurora Carneiro Zen.[29]

> 'An innovation ecosystem is based on a certain amount of governance by specific players. […] for an ecosystem to work, you need a certain number of roles, including: an orchestrator, an energiser, a webmaster, a community manager. There are a dozen roles that are coordinated within a governance mechanism. […] without these roles, there is no ecosystem.'
> — Patrick Cohendet (23 February 2023) *Cartographie des écosystèmes d'innovation en santé: démarche et recommandations pour les intermédiaires d'innovation* [Webinar]
> www.4point0.ca/s/3639

Each of these roles involves a specific set of activities and reflects a particular orchestration approach (directive, collaborative or hybrid) adapted to the complex, multi-dimensional nature of the orchestrator. Thus, in a directive approach aimed at connecting several actors in the ecosystem, it can play the role of architect by strategically defining the objectives and rigorously selecting the players capable of contributing complementary resources from a variety of universes. Conversely, by opting for a collaborative approach, it will adopt more of a facilitating role, creating contexts conducive to open, cross-disciplinary exchanges between the various actors, stimulating cross-sector innovation.

For example, network stability can be ensured through the use of binding legal agreements (directive orchestration) or by regularly convening key participants for joint sessions to foster a collective identity (collaborative orchestration).

Global orchestration

The introduction briefly mentioned global orchestration as involving coordination with other innovation ecosystems, monitoring knowledge and entrepreneurial ecosystems, and anticipating value capture needs in business ecosystems.

Global orchestration involves structuring, coordinating and energising the interactions between several interrelated ecosystems, including the knowledge ecosystem, the business ecosystem and the entrepreneurial ecosystem. This extended role of the innovation ecosystem orchestrator is based on its ability to simultaneously link and structure several distinct sub-ecosystems, notably those of knowledge, business and entrepreneurship, by deploying specific orchestration processes. These processes, such as knowledge mobility, equitable appropriation of innovation, and network resilience, each comprise clearly defined activities designed to facilitate effective interaction between players from different backgrounds (researchers, entrepreneurs, large companies, public institutions, etc.).

The way in which the orchestrator implements these activities – whether it chooses a directive, collaborative or hybrid approach – determines precisely the role it plays in connecting these different ecosystems. For example, in order to ensure the mobility of knowledge between the academic research ecosystem and the business ecosystem, the orchestrator can adopt a collaborative orchestration approach by setting up open spaces that encourage dialogue between researchers and businesses, or opt for a directive orchestration approach by managing a centralised technology platform that directly facilitates the transfer of innovations to economic players.

Complex networks composed of entities dedicated to knowledge, entrepreneurship, and business are characterised by a crucial yet often fragmented interdependence. This fragmentation hinders the smooth transition from research, S&T to commercial and societal applications, thereby limiting value creation and sustainable transformation of the environment. This adds a level of complexity to the orchestration role.

Passalacqua[f] emphasises that multilayered innovation ecosystem mapping sheds light on the intricate web of relationships within and between various ecosystems. This approach fosters informed and strategic decision-making, ultimately leading to enhanced growth, innovation, and sustainability. With Cohendet and Beauchesne, she recommends that to

create more value, both a business ecosystem and a knowledge ecosystem be developed, ensuring that the knowledge generated is also captured.

It is in this context that the concept of **global orchestration** takes on its full meaning. Far beyond a conventional orchestrator, the global orchestrator operates multidimensionally, integrating and coordinating disparate dynamics of different ecosystems. It acts as the catalyst that unifies knowledge flows, stimulates synergies between stakeholders, and creates innovative bridges to transform ideas into concrete solutions. As Richard Shearmur, David Doloreux and Iryna Fil-Kristensen explain, '*at the national […] scale, domains themselves interact, and this interaction can be orchestrated to produce new paths, innovation, and productivity*' (p. 488).[30]

> 'One of the very important aspects of these roles is when we try to coordinate, or couple, two ecosystems. Immense sources of value lie in the coupling of two ecosystems. And very often, when we try to link two ecosystems together, we find ourselves in a situation that sociologists call a structural hole, where the creation of value lies in weaving links between the two ecosystems, for example health and ageing. This is precisely where the specific role of certain players becomes even more important. In other words, coordination, the boundary spanner between two ecosystems – in other words, a certain number of role combinations – is essential.'
> — Patrick Cohendet (23 February 2023) *Cartographie des écosystèmes d'innovation en santé : démarche et recommandations pour les intermédiaires d'innovation* [Webinar]
> www.4point0.ca/s/3639

As Qiantao Zhang, Shiri M. Breznitz, and Steven Denney [31] rightly observe, organisations do not change independently. They must engage with suppliers, clients, and investors who are all interconnected. Firms must participate in cross-sectoral networks where they collaborate, cultivate competencies, and co-innovate.

This raises a fundamental question: **How can a global orchestrator structure, coordinate, and effectively energise interactions between knowledge, business, and entrepreneurial ecosystems?** What mechanisms and processes assist the global orchestrator to transcend traditional silos, promote the fair adoption of innovation, and facilitate its market diffusion?

A concrete example of global orchestration is that of the ENCQOR 5G consortium, which has successfully coordinated diverse stakeholders to accelerate the adoption and commercialisation of 5G technologies across Canada (see Box **2-2**).

Box 2-2 – ENCQOR 5G as a global orchestrator

ENCQOR 5G perfectly embodies the role of a global orchestrator, connecting businesses, startups, researchers, and public institutions to structure and accelerate 5G innovation in Canada. This innovation ecosystem mobilises knowledge, ensures the fair adoption of innovation, and strengthens the resilience of the innovation network.

ENCQOR 5G is a collaborative initiative, bringing together the public and private sectors, involving multiple levels of government (Canada, Quebec, and Ontario) and five multinational companies specialising in information and communication technologies

(Ericsson, Ciena, Thales, IBM Canada, and CGI). This large-scale project, co-funded by public and private partners, aims to drive research and innovation in 5G technology. It is particularly focused on establishing a pre-commercial digital corridor for 5G telecommunications, deployed across several strategic sites hosted by five innovation hubs.

The initiative also integrates research and innovation intermediaries that mobilise the ecosystem, with its coordination managed by a nonprofit organisation specifically created for this mission. Over its first five-year period, ENCQOR 5G aimed to raise awareness, engage, and support SMEs to prepare them for the 5G era, positioning the country as a leader in technological transition and catalysing innovation in key sectors such as smart cities, telemedicine, autonomous driving, and the Internet of Things.

Orchestration process of the ENCQOR 5G ecosystem

1. Promoting knowledge mobility

From its inception, ENCQOR 5G has promoted knowledge mobility by actively bringing together stakeholders from academic, industrial, and entrepreneurial sectors through forums, seminars, and targeted workshops. These gatherings have made it possible to jointly identify specific technological challenges related to 5G deployment and to align scientific advancements with concrete industrial needs.

Subsequently, ENCQOR 5G provided stakeholders with physical and digital collaborative platforms – true hubs where resources, data, and feedback could circulate freely among ecosystem members. By removing barriers to accessing strategic information, these platforms have enabled companies, particularly SMEs and startups, to effectively absorb the technological knowledge necessary for their innovation projects.

To materialise this knowledge mobility, ENCQOR 5G coordinated specific collaborative projects, bringing together complementary expertise from different sub-ecosystems. Through these structured projects, stakeholders were able not only to share their respective expertise but also to transform these exchanges into tangible technological development initiatives. This collaborative environment enabled SMEs to test and demonstrate their innovative solutions in real-world conditions, facilitating the direct integration of knowledge into industrial contexts and enhancing their attractiveness to investors.

Finally, the strategic involvement of research and innovation intermediaries allowed ENCQOR 5G to sustainably energise inter-ecosystem exchanges. These intermediaries facilitated the identification of relevant partners and the establishment of effective collaborations between researchers and businesses, ensuring a continuous and structured flow of knowledge throughout the project's duration.

2. Ensuring fair adoption of innovation

From the outset of the project, ENCQOR 5G established a structured and inclusive governance framework, clearly defining the roles and expected contributions of each stakeholder – multinational corporations, SMEs, startups, and researchers. This

governance was supported by a nonprofit organisation (NPO) specifically created to manage and coordinate all initiatives. Acting as a neutral intermediary, this organisation ensures balance and impartiality in the distribution of innovation benefits.

A transparent process was also implemented for the admission of SMEs and startups into the project. This process includes an initial technical evaluation conducted by infrastructure providers, followed by a final validation by an independent expert committee. This objective and well-defined approach ensures that member selection is based solely on technological relevance and innovation potential, reducing the risks of inequality or favouritism.

Furthermore, ENCQOR 5G actively protects the interests of SMEs by allowing them to retain full intellectual property rights over their innovations during the experimentation phase. This mechanism prevents any undue appropriation of their innovations by participating multinational corporations, ensuring a fair distribution of the value created.

3. Strengthening network resilience and stability

In response to external disruptions caused by the pandemic, ENCQOR 5G deployed agile mechanisms to ensure the stability and resilience of interactions between knowledge, business, and entrepreneurial ecosystems. At the first signs of disruption, crisis committees were quickly established to identify and implement appropriate solutions. Their primary objective was clear: to maintain the continuity of ongoing projects while adapting to fluctuating health and regulatory constraints, such as site closures, restricted access, and limitations on the number of participants in experimentation platforms.

For instance, in response to health restrictions affecting experimentation spaces, ENCQOR 5G introduced a hybrid solution that allowed SMEs to access technology platforms remotely, even if only partially. Although these adaptations had some limitations, they enabled businesses to continue their experiments and maintain their technological momentum. This organisational flexibility proved essential in ensuring the resilience of the network in the face of the pandemic.

4. Maintaining ecosystem connectivity and economic resilience

At the same time, to preserve connections between ecosystem stakeholders despite restrictions on physical gatherings, ENCQOR 5G adapted its outreach strategies by prioritising digital channels such as interactive webinars and virtual information sessions. These virtual meetings allowed SMEs, researchers, and large companies to maintain regular communication, thereby strengthening network cohesion in a period of uncertainty.

Recognising that crises also impact economic and commercial aspects, ENCQOR 5G promoted the proactive diversification of partnerships and funding sources. This strategic approach aimed to reduce critical dependencies on specific partners or resources, mitigating risks associated with crises. For example, in response to supply chain disruptions affecting 5G equipment during the pandemic, SMEs received support from ENCQOR 5G to identify alternative supply channels and minimise delays in their projects.

— Anas Ramdani

In a conversation with Alain Lemieux, CEO of the 'Vallée de la transition énergétique' [or Energy Transition Valley, one of Quebec's innovation zones], we discussed the need for the zone to work closely with the innovation and business ecosystems in the mining and advanced materials sectors, stressing the importance of global orchestration between these ecosystems to ensure the EV battery supply chain, for example. The only way to generate added value in this country is to transform rather than export directly. As I wrote in La Presse on 11 March 2025: 'It is regrettable that there is still no solid domestic market for our critical minerals! [...] It is vital to minimise the transport of minerals and greenhouse gases, from extraction to refining, and then to processing into advanced materials or finished products.'[32]
— Catherine Beaudry

'The strength of an economy lies in an ecosystem that supports research and the development of new technologies and processes. Collective enrichment is achieved through the strategic links between different players from a number of complementary and cross-disciplinary ecosystems, all of whom are involved in the successful exploitation of our talents, innovations and natural and clean resources. The current geopolitical and market context offers a sea of opportunities. It's up to us to seize all the potential in a drive to "DO IT TOGETHER".'
— Alain Lemieux, CEO, Vallée de la transition énergétique (19 March 2025)

Conclusion

Effective orchestration demands a deep understanding of context-specific conditions, strategic flexibility, actors and stakeholder dynamics. What succeeds in one environment may falter in another; orchestrators must therefore remain adaptive, sensitive to ecosystem nuances, and responsive to emerging challenges and opportunities.

Ultimately, mastering ecosystem orchestration is not merely about structural coordination; it is about cultivating the dynamic interplay between vision and execution, coherence and agility, control and openness. As innovation ecosystems continue to expand in complexity and interconnectivity, refining our grasp of these nuances of orchestration will become increasingly indispensable, setting apart ecosystems that merely survive from those that truly thrive.

Further information

The combined contributions of the members of 4POINT0 and some of the researchers mentioned in this chapter illustrate the multifaceted nature of innovation ecosystems.[5, 14, 17, 21, 23, 33-37] They reveal how governance, creativity, trust, community engagement, technological integration, and policy alignment intersect to drive ecosystem success. These practices form a cohesive framework for innovation ecosystems, ensuring their capacity to adapt, thrive, and generate sustainable and scalable solutions for economic, technological, and social challenges, creating long-term impact.

Closely related to knowledge and innovation ecosystems, the concept of knowing communities [35] and knowledge commons,[25, 38] as developed by Cohendet et al., is particularly relevant for readers who wish to further explore the role of commoners [5] in building a series of innovation commons to contribute to the emergence of innovation ecosystems. Their role is very much complementary to that of the orchestrator. The commoners are key actors in these commons, with the role of facilitating linkages between actors, hence contributing to the emergence of innovation ecosystems and their orchestration.[5]

> ‘Formal and informal actors, through their local interactions, complement and nourish each other by offering an alternative to the top-down and bottom-up processes that each type of actors may struggle with, or may be ill-adapted to carry out on its own.’
> — David Grandadam, Patrick Cohendet, & Raphaël Suire (p. 1578)[25]

> ‘The local innovation commons establish a truly open, dynamic and shared localized ecosystem that favors the implementation and reinforcement of a collaborative and integrated innovation value chain, articulating knowledge production, generation, experimentation and validation of new ideas, as well as the concrete development of innovative projects.’
> — Patrick Cohendet, David Grandadam, & Raphaël Suire (p. 6)[22]

Chapter 3
Processes and Practices for Leveraging Innovation Ecosystems

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> 'To find innovative solutions, you have to go through good solutions and not-so-good ones and accept that at some point you don't know where you're going. You have to accept that you're navigating in the dark, on a path that's poorly mapped out, but that we're going to map out by working together.'
> — Marie-Ève Milot, architect and certified coach, Collaborative experience Director at L'Atelier Urbain (cited in FORMES, p. 88)[39]

Introduction

Chapter 1 proposed a definition of the ecosystem, recalling the key concepts of a network of diversified players, formal and informal interactions between them and, finally, activities leading to the creation of value. Chapter 2 emphasised the importance of orchestration as a mechanism for coordinating this set of actors and activities. In this third chapter, we focus on innovation processes and practices.

According to Cohendet,[1] innovation ecosystems can sustain long-term innovation and adaptability in a rapidly changing world by focusing on generativity, resilience, and attractiveness. These three elements are interconnected and mutually reinforcing. Generativity refers to the ecosystem's ability to produce new ideas, innovations, and collaborative efforts. Resilience emphasises the capacity of the ecosystem to withstand and adapt to disruptions, maintaining or adapting its core functions and structures. The power of attraction relates to the ecosystem's ability to draw in diverse participants, resources, and investments, fostering a vibrant and dynamic environment for innovation. At the heart of the first element (i.e. generativity), creativity is a collective rather than purely individual endeavour. Cohendet et al.[21] specify that it is an organised activity that occurs within teams, organisations, and broader fields, such as innovation ecosystems. Through such an organised practice, creative ideas are developed, judged, and disseminated via interactions and negotiations among various actors and stakeholders.

> 'To develop the synergy we so desperately need, so that the ecosystem becomes more than just the sum of its parts, it is essential that the

> ecosystem also works on its dynamic capabilities, in parallel with our SMEs. This will enable us to achieve true complementarity, and everyone will be able to work together to ensure the sustainable deployment of innovation strategies. As we can see, it is too difficult for SMEs, which have limited resources and struggle to carry out innovation activities on their own. However, when they receive appropriate support from the ecosystem, they succeed. And the ecosystem, for its part, must ensure that it provides this support.'
> — Coralie Gagné (28 March 2024) *Nos PME pour le déploiement de stratégies d'éco-innovation* [Webinar]
> www.4point0.ca/s/6431

To unleash the potential of innovation ecosystem, various **processes** and **practices** are required. These essential concepts highlight different facets of how innovation emerges, develops, and persists. While processes focus on structuring sequences of activities to achieve specific outcomes, practices emphasise the habitual actions and behaviours that support collaboration and resource flow within the ecosystem. Together, these elements create a dynamic environment conducive to innovation.

At the firm level, businesses focus on systematically assessing the potential of ecosystems to enhance internal value creation and capture, often through top-down strategic initiatives led by senior management. However, beyond individual firms, a broader ecosystemic perspective is essential – one that fosters a shared vision among multiple actors and stakeholders to co-create, deliver, and share value. While the orchestrators discussed in the previous chapter may initiate such efforts, effective ecosystemic collaboration often relies on horizontal processes.

The processes and practices required for effective integration and performance differ depending on whether the issue is analysed from a firm level or an ecosystemic perspective. Operating within ecosystems presents unique challenges due to the diversity of actors involved – each with distinct, sometimes competing objectives, varying visions, and independent hierarchies, despite their interdependence. This chapter focuses on both perspectives. The firm-level perspective examines the specific processes and practices necessary for companies to successfully engage with and benefit from ecosystems, while the broader ecosystemic perspective includes the collective dynamics and governance of ecosystems.

Always looking at the crossroads between organisation-centric and ecosystem-based perspectives, we begin by exploring the concept of the innovation process; first by defining it, then by examining existing conceptual frameworks. Particular attention is given to contrasting the iterative nature of innovation processes with the more traditional linear models often used to represent them. This discussion leads us to the notion of roadmaps, which serve as a bridge to the strategic management of innovation. The discussion then shifts to innovation practices, bringing in related concepts such as corporate and ecosystem culture and governance. We conclude with a brief comparison between the concepts of processes and practices, highlighting their complementarities and areas of overlap. Throughout, these ideas are illustrated with real-world examples drawn from several research projects conducted during the 4POINT0 partnership.

Processes in innovation ecosystems

Processes within innovation ecosystems are typically systematic, goal-oriented sequences that outline how various inputs, such as knowledge, funding, and technology, are transformed into innovative outputs like products, services, or new business models. These processes are often structured to aim for efficiency and predictability, offering participants milestones for achieving desired outcomes. In many cases, the processes within innovation ecosystems propose a series of steps, allowing organisations to transform raw ideas into innovations that can be introduced into the market.

Let us assume that innovation is conceptualised as a set of interconnected steps, each influenced by both internal capabilities and external environmental factors. As suggested by Kostas Galanakis,[40] processes allow different actors in the ecosystem to collaborate and coordinate their activities toward a common goal. As innovation ecosystems continue to evolve, these processes may adapt to new technological trends or shifts in market demands, ensuring that they remain relevant and effective in boosting innovation.

Over the years, many authors have proposed various representations of innovation, often in the form of a formal process broken down into logically interrelated activities and punctuated by decision points, all leading to intermediate and final results. This is the general understanding of the notion of process, as proposed by ISO 9001:2015:[41] a set of interrelated or interacting activities that transform inputs into outputs. Observations in the field, however, show that innovation as-a-process is very rarely linear, and therefore does not necessarily follow a formal, predetermined sequence. Its point of departure is often diffuse, and takes shape when players mobilise to achieve a goal they wish to see materialise. In practice, as Juan-Luis Klein et al.[42] argue, this 'trajectory' therefore refers to 'different phases where, through back-and-forth, confrontations and alliances, advances and blockages, social actors lead to the organisational and institutional transformation of their communities' (p. 2).

> 'Innovation is a process that can be cultivated and improved. [...] the identification, exploitation and protection of intellectual property must be integrated into organisational processes and practices to maximise value creation.'
> — Nicolas Sacchetti [18]

Technological innovation experts Joe Tidd and John Bessant support such a view, reminding us of this socio-technical reality of the phenomenon:

'Innovation can be seen as a core process with a defined structure and a number of influences. This is helpful in terms of simplifying the picture into some clear stages and recognising the key levers [...] But like any simplification, the model is not quite as complex as the reality [...] The ways knowledge actually flows around an innovation project are complex and interactive, woven together in a kind of 'social spaghetti' where different people talk to each other in different ways, more or less frequently, and about different things.' (p. 256)[43]

In reality, innovation within an ecosystem must be described not by one process, but by several. These processes interact and co-evolve in a more or less predictable way

depending on the logic of action of the various members of the 'social spaghetti' described by the authors.

> '[Construction] innovation can be successful only when new or different interfaces are created between technical and organisational resources. Innovation is driven forwards by way of interaction and adaptation processes between actors and their resources.'
> — Finn Orstavik, Andrew R. J. Dainty, & Carl Abbott (p. 20)[44]

Innovation specialist Isabelle Deschamps [45] proposed a useful representation of this set of interrelated processes (see Figure 3-1 for an overview). According to her, the main challenge of an ecosystem is getting the players involved to initiate and support these processes in a coherent and synchronised way.

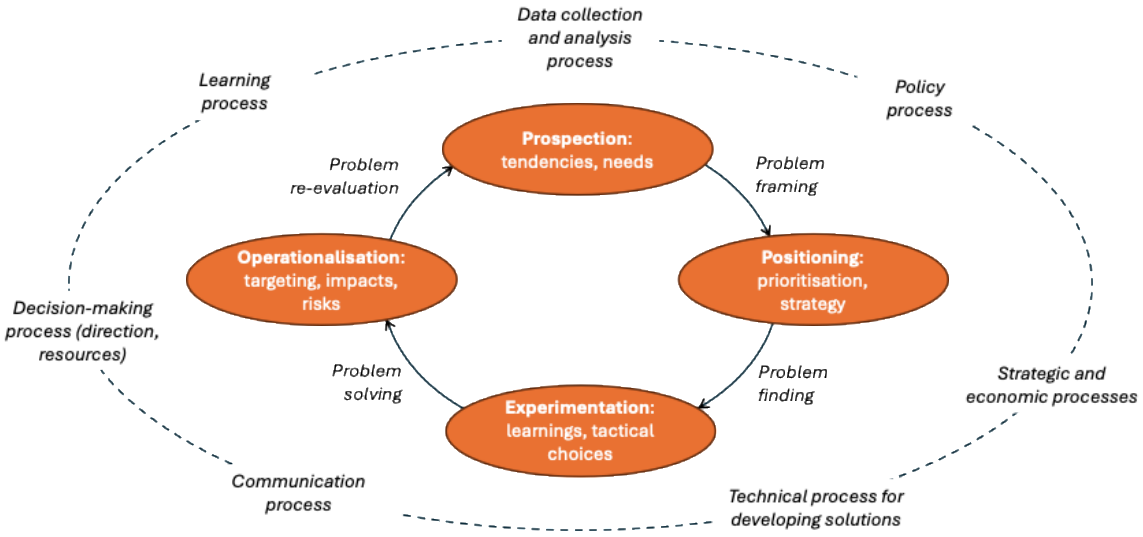

Figure 3-1 – Innovation viewed as the result of the interaction of several processes (adapted from Isabelle Deschamps' model[45])

Two levels of processes interact with each other. The central part refers to an approach centred around a 'problem' to be framed (framing), identified (finding), solved (solving) and the proposed solutions evaluated (re-evaluation). In reality, the circularity of this process is closer to a spiral, where several loops are often necessary to achieve a proven and viable result (technically, financially, etc.), while at the same time being legitimised and deployed within a given environment (market, jurisdiction, society, etc.). As well, a certain amount of to-ing and fro-ing is to be expected.

1) **Problem framing** is the result of a prospecting effort aimed at understanding, analysing and documenting a problematic situation in the eyes of certain actors who also see it as an opportunity for innovation. In the built environment ecosystem (see Box **3-1**), several groups exemplify this prospecting work. On a regular basis, Gonzalo Lizarralde, Mario Bourgault et al.[h] offer directories of studies on innovations such as integrated design process and wood prefabrication. Similarly, under the aegis of the CSA Group, Érik

[h] Extracted from the information platform available at: https://seminairesinterfaces.ca/ .

Poirier et al.[46] recently published a very detailed study proposing an operational framework to support implementation of Building Information Modelling (BIM) on a national scale.

Box 3-1 – The ecosystem of actors involved in the built environment

The notion of ecosystem is particularly well suited to what we refer to in this chapter as the 'built environment'. Canada's Chief Public Health Officer offers a pertinent definition: 'built environment is defined as the external physical environment where we live, work, study and play. It includes buildings, roads, public transit systems, parks, and other types of infrastructure. It is linked to how we design, plan and build our communities' (p. 6).[48] The ecosystem that contributes to designing and creating this built environment is therefore made up of a vast array of actors who may act in a complementary fashion, on a regular or ad hoc basis, depending on the service to be provided or the work to be delivered. As proposed by Michael Jacobides et al.,[49] this is indeed a 'set of actors with varying degrees of multilateral, nongeneric complementarities that are not fully hierarchically controlled' (p. 2264). This constellation of companies therefore goes far beyond official and sometimes simplistic classifications such as the 'construction industry'. Figure 3-2 illustrates this constellation.

Analysing the emergence and conduct of innovation processes in such an ecosystem therefore involves situating the players, their practices and the context in which they operate. These characteristics of the ecosystem can have a major influence on the way in which the trajectory of the innovation evolves and leads to the desired outcome. For example, the majority of companies involved in the design and construction of buildings are very small firms with little R&D activity. This results in practices and a culture that are relatively slow to adopt innovations, which could be described as a low 'absorption capacity', to use the concept put forward by Wesley Cohen and Daniel Levinthal.[50]

Figure 3-2 – Built Environment Ecosystem (adapted from SQI[47])

Understanding innovation in the built environment also requires an understanding of its practices. Because it is essentially based on a logic of prototyping, the works are often unique (e.g. the signature buildings of a municipality, such as a public library); the result is a need to reconfigure the relationships between players for each project. In this context of one-off exchanges for short periods, opportunities for establishing lasting collaborative links are slimmer than in other contexts or environments. While construction work practices are evolving in certain respects (e.g. health and safety), site management is still based on an artisanal approach, in the sense that multiple companies and trades are concentrated in these 'ephemeral cities' to assemble a complex structure.

Similarly, operating in environments that are open to the vagaries of the weather is an additional obstacle to controlling the working environment. Work repetitiveness,

integration of actors and systems, and control of the environment – three aspects on which the practices of conventional industrial environments are based – therefore pose a structural challenge in this sector. These are in addition to the various economic, political and institutional influences that can affect the environment.

2) Following the model of Isabelle Deschamps,[45] **problem finding** is the result of an alignment of stakeholders aiming to prioritise various possible initiatives and mapping out possible routes to innovation within an ecosystem. The numerous 'roadmaps' published by various public bodies are interesting examples of consultation and mobilisation of players and resources. These include the Quebec government's roadmap for infrastructure data modelling[i] and the Montreal circular economy roadmap[j].

3) **Experimenting and imagining possible solutions (problem solving)** play a central role in the innovation processes of an ecosystem, and do not only affect the technical or scientific dimension. In the built environment we studied, the viability of certain technological innovations remains subject to organisational, strategic and sometimes even regulatory changes. The case of integrated design process (see Box **3-2**) is an interesting example illustrating the interplay between various organisational and technical innovations.

> 'At the moment, professional architects and engineers often have to take on the risk and pressure associated with innovation themselves. It is rare for contractors, sub-contractors or clients to want to share risk management [...] risk management is not a one-off investment at the start of a project; it should be expressed at all phases of a project, including post-construction monitoring.'
> — Daniel Pearl, Professor, Université de Montréal (2 November 2023, 40:29, and 47:27) *Trajectoires d'innovation dans l'industrie de la construction* [Webinar]
> www.4point0.ca/s/5586

Box 3-2 – Working together for better innovation versus innovating in the ways we work together

Several 4POINT0 studies have highlighted the need to work together at individual, organisational and ecosystem levels. However, collaboration is not immediately natural when a group of actors get involved. In fact, the opposite is the norm. The studies show that players do not necessarily know how to work together – because wanting to collaborate is not synonymous with knowing how to collaborate.

One of the innovation trajectories studied by Lizarralde and Bourgault [39] is that of the 'integrated design process' (IDP) within the ecosystem of the built environment. Initiated in the field of sustainable building, the need to strengthen collaboration between designers and builders should lead to better integration of practices, resulting in greater

[i] https://www.sqi.gouv.qc.ca/fileadmin/fdr_bim_gouv/feuille_de_route_actualisee_au_31_mars_2025.pdf.
[j] https://portail-m4s.s3.montreal.ca/pdf/1503-01-economie-circulaire-document_85x11_vf_0.pdf

constructability, better coordination, and ultimately, infrastructures that better meet customer needs. Various mechanisms are being implemented, both technical (e.g. digital tools) and process-based (e.g. creating collaborative workspaces). Some of the results were published in a special issue of the magazine FORMES.[39] As reported in their article: '[...] *our work shows that notions of integration and collaboration vary enormously between industry players and within project teams. There is a growing interest in collaboration, but not everyone agrees on 'why', 'how', 'with whom', 'when' and the cost of doing so. That said, the scope and characteristics of integration activities need to be explored in relation to various definitions and measures of quality: effectiveness, efficiency, performance, quality of process, quality of end-products, and so on. More critical studies are needed on tools, techniques and the role of actors to improve the impact of collaboration in the building sector [...] IDP no longer just requires collaboration, but also boldness and flexibility. Boldness is the mother of new ideas, but you then need to be agile enough to assess their potential benefits and work out how to integrate them into the project*' (pp. 81; 88).[39]

4) **Evaluating proposed solutions (problem re-evaluation)** is the fourth component of the central model proposed by Deschamps. In any innovative process within an organisation or ecosystem, its value must eventually be demonstrated, however the players define it. In their study of the value of innovation, Lizarralde et al.[51] argue that innovation is not a strictly objective property inherent in potential change. Rather, it must be understood as a socially constructed quality, dependent on the perceptions of a given group of actors within a specific context. In this sense, innovation can only be considered as such if it is effectively adopted or recognised by the stakeholders concerned. Its legitimacy therefore depends on the capacity of these stakeholders to converge towards a shared appreciation. However, this process can often prove tricky, as the different groups involved may have divergent views on the values to be promoted. This is often the case in the built environment, where issues such as profitability, architectural quality and social acceptability come into conflict on a regular basis.

Despite the obstacles, measuring progress and results is therefore essential to assessing, convincing and correcting the trajectory. The aforementioned government roadmap initiative for infrastructure data modelling[i] is a very concrete example of measuring various facets of a systemic innovation (see Box **3-3**).

Box 3-3 – Quebec government's roadmap for infrastructure/building data modelling (BIM)

One of the key vectors of digital transformation of the built environment ecosystem is the building information modelling (BIM) platform. In fact, a significant number of innovations currently being adopted in this ecosystem, particularly in terms of automation or 4.0/5.0 technologies, are based on implementation of this technology. As explained by Poirier et al.,[46] the main aim of such a platform is to produce and exchange information about built assets amongst all those involved. Its implementation offers a host of advantages in terms of work planning, coordination of stakeholders from the design stage, decision-making, and so on. It is used throughout the life of the structure, from design to use and

maintenance. Although the adoption of BIM in Canada and Quebec was late compared to other countries, the last decade has marked a major turning point in BIM adoption thanks to the mobilisation of major players in the ecosystem, including the *Société québécoise des infrastructures* (SQI), BIM Québec, academic institutions such as École de technologie supérieure (ÉTS), and so on.

In 2021, the Government of Quebec published a first 'roadmap' aimed at developing a detailed strategy to guide and support the large-scale implementation of BIM. This strategy is based on mobilisation of the main public contractors in the ecosystem, who are the main instigators of large-scale projects in the province: the *Société québécoise des infrastructures* (SQI), the *Ministère des Transports et de la Mobilité durable*, the *Société d'habitation du Québec* (SHQ), Olympic Park, Hydro-Québec, the City of Quebec, the City of Longueuil and the City of Montreal.

This strategy sets out the action areas, the roles of the main players, the projects (activities) to be carried out within the set timeframe, and the expected results. This roadmap also incorporates a number of elements from established models, such as the logical framework discussed in Chapter 5.

For the SQI, initiator and champion of BIM implementation since 2009, this roadmap makes it possible '*to establish the pace of BIM implementation by setting concrete and realistic targets. It aims to ensure the successful deployment of BIM on a large scale [...] for all players involved in the lifecycle of Quebec's public built assets [...]. In addition to increased productivity, the benefits of the government's Roadmap mainly concern: stakeholder buy-in, the increased attractiveness of the construction sector to various categories of workers in the industry, the development and implementation of a common, collaborative vision, and greater visibility of projects for which public ministries and agencies are committed to implementing BIM practices, thus enabling the industry to prepare itself better.*'[k]

Since its launch, the roadmap has mobilised a substantial number of players in the ecosystem. As mentioned earlier in this chapter, the process of adopting such an innovation is not necessarily as linear as the roadmap might suggest. Some areas also progress at varying speeds. In the economic and political context of this ecosystem, in which major projects can be accelerated or delayed depending on government choices, the five-year time horizon also means adaptations along the way.

The governance structure of this ecosystem is therefore of vital importance in orchestrating all the players and proposing measurable targets for each of the axes. Orchestrating the ecosystem also means adapting these targets to obstacles that emerge over time. For example, during mid-term consultations, a number of small businesses highlighted the significant financial burden that adopting BIM could entail, as well as the low level of experience and skills that limits their ability to integrate these innovations.

[k] https://sqi.gouv.qc.ca/feuille-de-route-gouvernementale-pour-le-bim

> ‘Our study shows that innovation does not emerge naturally: a combination of factors is needed to ensure its adoption [...] Innovation is not always seen as valuable in itself; it may even be questioned by some practitioners who express legitimate concerns that go beyond simple resistance to change.’ — Sara Rankohi, Professor, UQAM (2 November 2023) *Trajectoires d’innovation dans l’industrie de la construction* [Webinar] www.4point0.ca/s/5586

Processes and the strategic management of technology

Processes are important because they provide a clear roadmap for innovation, ensuring that activities are carried out in an orderly manner. For instance, structured processes in technology transfer or collaborative R&D enable various stakeholders, including universities, companies, and public organisations, to align their efforts productively. This process orientation not only helps to reduce inefficiencies but also enhances coordination between actors, which, Henry Chesbrough[52] argues, facilitates the exchange of resources and knowledge that are essential for innovation. Furthermore, processes are deeply influenced by policy frameworks and market conditions, which shape how resources are allocated and how innovation is commercialised. Paavo Ritala et al.[53] suggest that this adaptability to changing contexts is a key feature of successful innovation processes, ensuring that they remain robust even in dynamic environments.

The idea of a roadmap evokes strategic management since it requires long-term vision to determine its destination. Moreover, every roadmap is situated from a starting point, which necessitates a clear and structured assessment of the current state of the organisation and ecosystem. Between its start point and destination, processes are required to transform a firm’s initial state (‘as-is’) to the desired state (‘to-be’). This transformation should be planned, designed and implemented. A traditional view presents strategic planning as a continuous cycle split into four stages (see Figure 3-3), each with its own processes, which require specific tools for completion.[54-56]

The first stage is about the determination of the current state, which comprises analysis of the business environment and internal business assessment. Tools often associated with this stage are internal assessment tools (e.g. SWOT[l] analysis, PESTEL[m] analysis and benchmarking) and business intelligence tools (e.g. needs analysis,[57] competitive watch, marketing studies and ecosystem mapping).

In the second stage, assessing the current state serves as the foundation for defining the desired future, which typically leads to establishing the mission-vision-values triplet. Several positioning and strategising tools are used to that effect, which include Michael Porter’s five competitive forces,[58] Kim Chan and Renee Mauborgne’s blue ocean strategy,[59] and Joao Gabriel Alves Ribeiro Rosa’s scenario planning tools.[60]

[l] Strengths, Weaknesses, Opportunities, and Threats.
[m] Political, Economic, Social, Technological, Environmental, and Legal Factors.

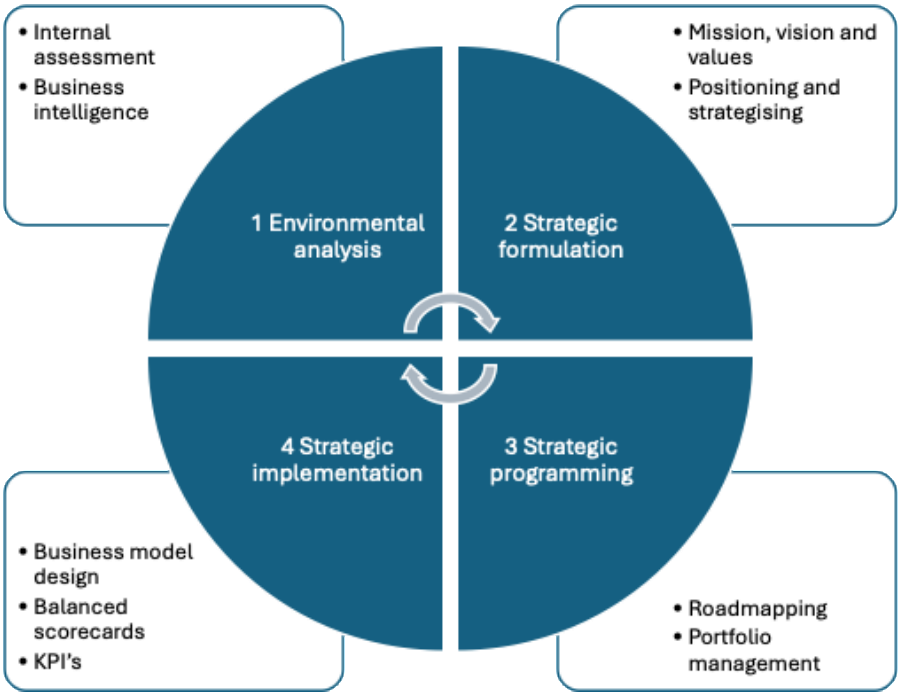

Figure 3-3 – The four stages of strategic planning at the firm level

The third stage is where strategic planning takes place: strategic, technology and product road mapping tools [61, 62] are often applied, as well as other strategic programming tools, such as gap analysis and portfolio management.[63, 64]

Finally, the fourth stage is about implementation of the strategic plan and its follow-up. Since it is strategy that drives the business model, it is also at this stage that business model design takes place. Tools and processes often employed here include the business model canvas, Robert Kaplan's balanced scorecards,[65] and key performance indicators (KPIs).

These steps can all be transposed to the ecosystem level, as an ecosystem is also submitted to a business environment that needs to be assessed. Among an ecosystem's players, it has a set of 'internal' competencies and resources[n] that need to be acknowledged beforehand. A clear mission and value proposition must be shared among all ecosystem players, and a plan (a roadmap) must be created, implemented and closely followed.

Nevertheless, such an undertaking will require new tools, as the existing tools for planning or organising innovation processes were not conceived to address ecosystem challenges. This is one of the conclusions of Zahida Benraïs,[66] whose doctoral thesis revealed, through data analysis of a survey of technology managers around the world, that the role and involvement of companies in their respective ecosystems had no influence on the deployment of their respective technology strategy plans. In other words, since the tools used to develop these plans did not systematically take into consideration the leverage opportunities offered by their ecosystems, they were simply not targeted by companies.

[n] Chapter 5 explores these ecosystem inputs and resources in different impact and logical frameworks.

For example, informal networks like communities of practice play a pivotal role in fostering innovation.[23] Such communities are spaces for knowledge sharing and skill development across organisational boundaries. Several noteworthy cases demonstrate the role of technical tools in fostering ecosystem collaboration and facilitating deployment of these tools. The integration of advanced technologies is essential to optimise ecosystem performance. Sara Rankohi, Mario Bourgault, Ivanka Iordanova, and Carlo Carbone[67] explore how frameworks like Design for Manufacturing and Assembly (DfMA) leverage tools such as Internet of Things (IoT), 3D printing, and cloud computing to enhance operational efficiency in construction. Similarly, Elena Gorachinova and David Wolfe [36] examine the integration of connected and autonomous vehicle technologies in the Ontario automotive sector, emphasising collaborative roles between original equipment manufacturers (OEMs), information and communications technology (ICT) firms, and academic institutions. These practices highlight the sector-specific potential of technological synergies to address challenges and drive innovation. Tools like codebooks facilitate the transfer of expertise, democratising innovation processes and enhancing ecosystem adaptability. David Doloreux and Anthony Frigon [68] expand on this concept with their exploration of institutional entrepreneurship, where collective action institutionalises transformative innovations. Additionally, community-driven innovation, in which informal collectives prioritise societal causes and resilience, enhances creativity and agility.[35] This helps organisations respond effectively to external shocks, as seen during crises like the COVID-19 pandemic.

Certain 4POINT0 research projects aimed to fill this gap. At the firm level, Nihad Bassis [69] developed and tested in three different companies an ecosystem qualitative assessment tool (AStra) to help companies rethink their business models looking at leveraging opportunities offered by players in their respective ecosystems. Valentine Mas [70] customised Phaal's S-Plan,[61] a renowned strategic roadmapping tool, to systematically assess the needs and capabilities of the ecosystem while drawing the company's internal strategic roadmap for artificial intelligence (AI) technologies. In doing so, she also proposed a performance indicator of companies to measure the AI readiness of companies in the ecosystem. At the ecosystem orchestration level, Alice Lena [71] developed a tool to align the strategic vision of players within an ecosystem and applied it to the manufacturing ecosystem of a municipality in Quebec.

These are definitely important first steps, but much remains to be done to fully equip companies and ecosystem orchestrators with customised tools for the design and deployment of strategic plans in the era of ecosystem collaboration.

> 'Internal alignment occurs among IE [innovation ecosystem] members when they share objectives, goals and roadmaps.'
> — Giulia Piantoni, Marika Arena, & Giovanni Azzone (p. 212)[72]

Practices in innovation ecosystems

If processes are systematically organised activities, practices in innovation ecosystems are, in contrast, primarily concerned with the everyday behaviours, routines, and interactions in which ecosystem participants engage. These practices are often informal, focusing, for instance, on the ways in which individuals and organisations collaborate and share resources within the ecosystem. Innovation practices are also strongly influenced by

organisational culture, which Spencer Harrison and Kevin Corley [73] define as a long-lasting set of shared attitudes, values and meanings that influence the thinking and behaviour of members of a company.

Practices are central to creating trust, open communication, and the continuous exchange of knowledge – crucial elements for sustaining a productive innovation ecosystem. The dynamics between ecosystem participants – such as companies, universities, and governmental organisations – are shaped by these practices, which can include collaborative problem-solving, networking, and informal exchanges of expertise. In reality, ecosystem practices and policies are of little value if ecosystem stakeholders do not adopt the practices and postures necessary to seize the opportunities it offers. This was made very clear by Sophie Veilleux, who emphasises the fact that, before ecosystem mechanisms can help businesses grow, we must change the culture of businesses so that they want to grow:

> 'How can innovation ecosystems foster business growth? The fundamental answer is this: entrepreneurs' growth intentions are paramount from the very start. Therefore, in our ecosystem and region, we must value business growth and, above all, perceive it as achievable. To foster innovation, it is necessary to foster an entrepreneurial culture.'
> — Sophie Veilleux (24 February 2021) *Être ou ne pas être une licorne?* [Webinar]
> www.4point0.ca/s/1674

Closely related to the orchestration role described in Chapter 2, governance practices are an important component of innovation ecosystems. These practices involve the establishment of shared norms, decision-making mechanisms, and conflict resolution strategies, all of which help to align the often-divergent interests of ecosystem participants. Governance practices ensure that all actors within the ecosystem are working towards common goals and that they have the tools and frameworks necessary to resolve any disagreements or challenges that may arise. These practices are vital to ensuring the sustainability of the ecosystem over time, as they foster long-term relationships and encourage participants to remain engaged and committed to the collective objectives.

To ensure that these collective objectives are achieved, a number of collaborative practices need to be implemented. Collaborative practices**,** such as co-creation workshops and open innovation activities, allow organisations to work together, sharing their knowledge and resources to develop new solutions. These practices encourage knowledge sharing across organisational boundaries, allowing participants to leverage diverse perspectives and skills to address complex challenges. In an increasingly interconnected world, these types of practices are especially vital in ecosystems where innovation often relies on the contributions of multiple actors, each bringing a unique set of expertise and resources to the table (see, for instance, the work of Henry Chesbrough and Marcel Bogers[74]).

At the firm level, organisational culture plays a crucial role in either fostering or hindering a company's ability to create and capture value from its ecosystem. According to Fabiano Armellini et al.,[75] an organisational culture that fosters openness, collaboration, and knowledge sharing enhances a firm's capacity to integrate external ideas and technologies, leading to improved innovation outcomes. In contrast, firms with rigid or closed cultures face

challenges in adopting open innovation strategies, limiting their ability to leverage external collaborations. These authors found that the organisational cultural factors that were particularly related to innovation practices and initiatives were trust, openness, employee participation, commitment to innovation and the expectation of always being in the technological vanguard.

At the ecosystem level, it is reasonable to assume that best practices should also yield to superior performance. At this level, though, the specialised literature is less prolific in proposing best practices for the mechanisms and collaborative spaces set up for the interaction of players within an ecosystem. Two combined studies from the 4POINT0 partnership contributed to filling this gap in respect to one of these collaborative spaces: the so-called open innovation events. In the first study, Gagné et al.,[76] through interview-based, inductive qualitative research, developed performance indicators for the success of OI events; in the second study Basile Thisse et al.,[77] through survey-based deductive quantitative research, tested and validated these indicators. The indicators developed for these studies are presented in depth in Chapter 5. Nevertheless, what is important in the present chapter is the fact that their conclusions allowed for the identification of best practices that can be translated to both the event design and the behaviour of participants before, during and after the event. Box **3-4** summarises the best practices identified in these studies.

Box 3-4 – Open innovation events and best practices

Open Innovation (OI) events are structured gatherings, such as hackathons, crowdsourcing challenges, and design competitions, that bring together diverse participants to collaboratively solve industry-specific problems, drive innovation, and create value.

Best practices for OI events, which also include success indicators and impact measures (see Chapter 5), allow each stakeholder to get the most out of their participation in these events, as well as to maximise the value they share with other stakeholders in their ecosystem.

OI events involve five types of actors: **sponsors** fund the event; **promoters** organise it; **intermediaries** act as liaison officers between different types of actors and stakeholders (e.g. universities and companies), and play an important role in recruitment of event participants; **seekers** propose the challenge or industry problem to be solved; and **solvers** (event participants) try to propose the best solution to the problem.

Some best practices for enhancing the impact of OI events are common to all stakeholders. These include demonstrating commitment and openness, focusing on relationship building, engaging in dialogue with diverse stakeholders, finding a balance between activities and joint initiatives, staying connected to one's network, and documenting ideas and contacts for future reference.

Most stakeholder-specific best practices focus on the promoters (event organisers). Understandably, it is important for promoters to consider the event as a whole – before, during and after the event, and its context.

Before the event, promoters must seek to create a value-added experience for participants, consider the entire ecosystem and its event calendar, insert the event into a continuum of activities, manage expectations and educate participants. Promoters must also be transparent, focus on upstream preparations, collect information on event topics, organise events that are balanced in terms of the effort required from participants, avoid excessive structuring, recruit participants with adjacent expertise and from broad networks, attend to the writing of public communications, develop a culture of continuous learning, and stay connected to the ecosystem network.

During the event, it is important for the promoter to collect data on participants, maintain a resource log, stay connected to their network, present challenging projects with specific instructions, be active in team building, use common digital platforms to encourage exchanges, maintain a cooperative climate, increase hedonic benefits, offer more performance-related prizes and rewards, and avoid soliciting public feedback unless the goal is breakthrough innovation (because in this case, public feedback may help solvers to identify blind spots, unmet needs and encourage refinement and iteration with potential users).

After the event, it is important to continue to build and maintain the event's network. It is recommended that the promoter stays in contact with participants, offers other opportunities to participants, strengthens the event's brand image, stays connected to their own network, conducts post-mortem evaluations with sponsors, and uses the results of evaluations for subsequent events. Thus, through these types of OI events, promotors play a key role in network cohesion and resilience within the innovation ecosystem.

Other best practices were also identified by the research team for the other types of stakeholders.

Sponsors of OI events should focus on creating strong ties with promoters and other partners within complementary networks, developing close contacts, and ensuring mutual benefits for each involved stakeholder. Sponsors must also look beyond the direct participants of the event to the entire ecosystem, because of the spillover effects of such events. And lastly, sponsors should consider offering more prizes to participants, and ensure these prizes and rewards are tied to participants' performance.

For **intermediaries** whose role is to share the event with their respective networks, it is important to recruit participants with adjacent expertise, consider the entire ecosystem (as for sponsors), and use community platforms (digital or not) where the group of interest can be found, for communication.

Turning to the more technical **participants**, seekers should present motivating projects to attract the participation of problem solvers and provide guidelines so that the product or solutions are useful to them. Quantitative testing of these indicators across several OI events in Quebec revealed that certain event design elements significantly impacted outcomes for solvers. We found that the intrinsic motivation of solvers plays a moderating role in the success of these events. This motivation can be achieved through, for example, the presence of mentors during the event, which is positively corelated with the

continuation of the partnership after the event, and, consequently, in increasing solvers' capacity to interact with the innovation ecosystem.

Finally, the **solvers**, whose aim is to propose solutions to the problems faced by seekers, should concentrate on rapidly developing a prototype at the beginning stages of the event, adapt their ideas to the feedback received, use community platforms, and adopt an ethical behaviour. The goal being that the solutions developed will be of use to the seekers. With respect to solvers, our quantitative testing in Quebec revealed that the more solvers are connected to the ecosystem before the event, the more they take advantage of their participation in the event, which shows the relationship between these two elements.

Open innovation events are one example of key activities that contribute to maintaining innovation ecosystems at the forefront of technology advances, while continuously building and strengthening new collaborative ties therein, since they generate a more positive attitude towards openness among participants.

Once some of these new ideas have been further developed, they may require creation of a new entity for commercialisation purposes. This is where entrepreneurial practices play a key role in innovation ecosystems, as they provide the mechanisms for individuals and organisations to take ideas to market. Entrepreneurial practices such as pitching to investors, navigating intellectual property rights, and engaging in industry-specific networking events enable entrepreneurs to mobilise the resources they need to bring their innovations to fruition. These activities are not only instrumental towards securing financial backing but also help build the reputation and credibility of entrepreneurs within the ecosystem, which can open up further opportunities for collaboration and growth.

Initiatives for developing translational entrepreneurial skills are therefore of utmost important for innovation success within the local entrepreneurial ecosystems in which they are developed. One such example, to be detailed in the next chapter, is the invention to Innovation (i2I) programme developed a decade ago by Elicia Maine at Simon Fraser University, and deployed today in several institutions of 4POINT0 members.

Conclusion

Although processes and practices are distinct in nature, they are interconnected and mutually reinforcing within innovation ecosystems (as summarised in Table 3-1). Processes provide the structural framework for innovation, ensuring that activities unfold organisationally and efficiently. However, the success of these processes often depends on informal, relational aspects like practices. For example, a process for commercialising a new product may lay out the necessary steps for taking the product to market, but the success of each step may be equally dependent on underlying practices like stakeholder engagement, trust-building, and networking. According to Paavo Ritala and Argyrohis Almpanopoulou,[78] this dynamic interplay between formal processes and informal practices highlights the co-evolutionary nature of innovation ecosystems, where both structure and social interaction work together to create an environment supportive of innovation.

Table 3-1 – Processes versus practices

	Processes	Practices
Scope	Structured workflows	Informal routines, behaviours and organisational culture
Temporal Nature	Sequential and systematic	Repeated and habitual
Focus	Transformation of resources	Social and relational dynamics
Purpose	Achieve specific outcomes	Facilitate collaboration

It is important to stress once again that processes are simply models of the ideal path to achieve a result. The reality of a process is usually not so clear cut, nor does it usually unfold as planned, which means that plans often need to be revised.

The co-dependence of processes and practices also underscores the importance of flexibility in innovation ecosystems. While processes may provide clear guidelines, they must remain adaptable to accommodate the ever-changing nature of technological advancements, market trends, and organisational needs. At the same time, practices must evolve to reflect ongoing changes within the ecosystem, ensuring that participants continue to collaborate in ways that maximise the collective value of the ecosystem.

Together, these elements create a robust foundation for innovation, ensuring the smooth flow of knowledge, resources, and creative solutions.

Chapter 4
Innovation Policies

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> 'Innovation ecosystems are of great interest to public policy. Governments at all levels are looking for ways to measure competitiveness and encourage innovation, improved living standards and business growth. Canada's Innovation Supercluster Initiative is developing ecosystem nests to boost regional innovation.'
> — Manassé Drabo, research analyst, Statistics Canada (29 September 2023) *Innovation ecosystem performance indicators: Review of the literature* [Webinar]
> www.4point0.ca/s/5185

Introduction

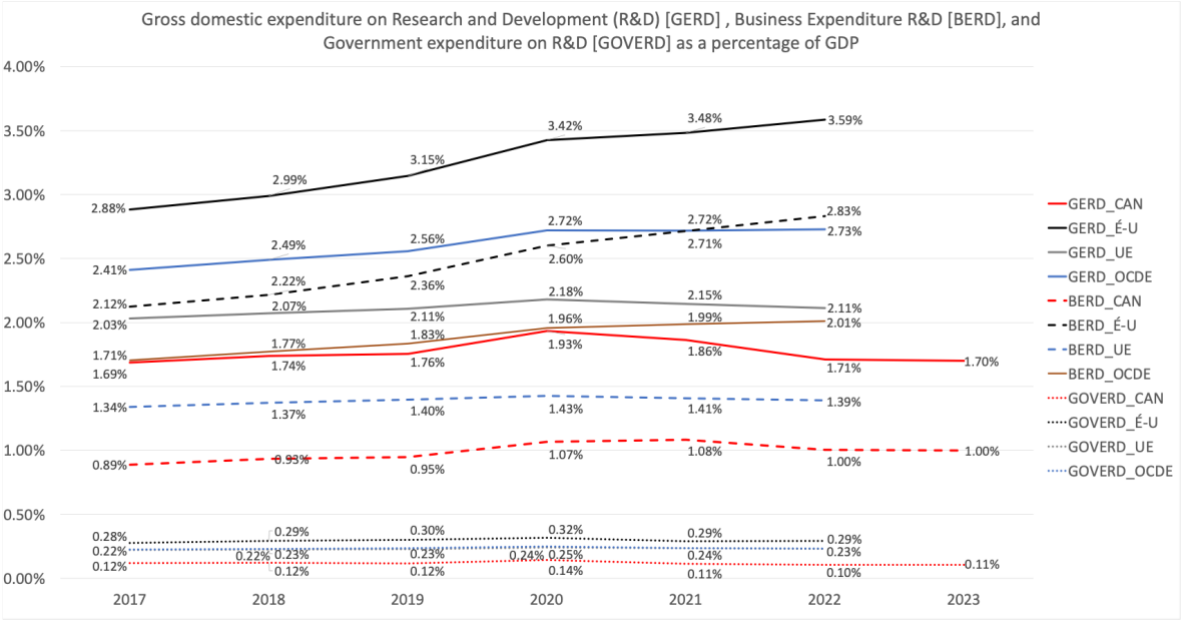
At the beginning of 4POINT0, Canada was struggling to transform its strength in S&T into innovation impact. This is a problem that the country has yet to resolve. Five years post pandemic, in the midst of a tariff war, Canada is still not strong enough to face the powerful headwinds that seem to be blowing from all directions. Canadian productivity has stagnated for the better part of a decade,[79] and according to the Conference Board of Canada, in innovation we fall below the OECD average, ranking 15th.[80]

Typical science, technology and innovation (STI) policy tools include direct funding, tax incentives, and research grants supporting universities and private-sector R&D, such as Canada's Scientific Research and Experimental Development (SR&ED) tax credits, Tri-Council research funding,[o] and academia-industry collaborations.

[o] The Tri-Council comprises the three federal granting agencies that fund research at Canadian post-secondary institutions: the Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC), and the Social Sciences and Humanities Research Council (SSHRC).

Despite these initiatives, Canada does not invest enough to move the dial – and both firms and the government are guilty in this regard. Figure 4-1 highlights our low R&D investment compared to other countries.

Figure 4-1 – GERD, BERD and GOVERD – Canada, US, EU, OECD – 2019-2023



Source: OECD Main Science and Technology Indicators Database[p]

In this context, innovation policies that aim to boost economic growth and societal progress by supporting research, entrepreneurship, and the commercialisation of new technologies will likely be insufficient. Coordinated innovation and industrial policies that specifically focus on turning scientific discoveries into market-ready products are needed.

Stimulating entrepreneurship and supporting business expansion, particularly in technology, are inextricably linked to establishing and developing robust, resilient, and dynamic innovation and entrepreneurial ecosystems. These ecosystems are characterised by their ability to cultivate a culture conducive to initiative and risk-taking, guarantee simplified and equitable access to essential resources and offer a structure fostering fluid interactions and fruitful collaborations among diverse players. Sophie Veilleux, Fabiano Armellini and Carine Ferrey [81] suggest that public policies and university strategies are decisive levers, acting as key catalysts and facilitators. These policies are most effective when finely tuned to respond appropriately to businesses' evolving needs as they develop. For instance, their role includes encouraging calculated risk-taking and supporting all forms of innovation (technological, organisational, and social).

p https://data-explorer.oecd.org/vis?df[ds]=dsDisseminateFinalDMZ&df[id]=DSD_MSTI%40DF_MSTI&df[ag]=OECD.STI.STP&vw=tb&lc=en&dq=USA%2BEU27_2020%2BOECD%2BCAN.A.GV%2BB%2BG%2BT_RS.PT_B1GQ..&lom=LASTNPERIODS&lo=5&to[TIME_PERIOD]=false&pg=0

This chapter focuses on the various policies that contribute to driving innovation, and in particular on those studied by 4POINT0 team members to shed some light on current trends. The first section covers the specific and interrelated roles of entrepreneurial and innovation ecosystems. This chapter will therefore cover a few of the programmes, specific to entrepreneurial ecosystems, academic entrepreneurship and entrepreneurial education, and incubators and accelerators. We will then present a few general STI policies pertinent to ecosystems. Lastly, we will explore policies specific to ecosystem building, such as Quebec's innovation zones (*zones d'innovation*) and the Global Innovation Clusters Programme (previously known as the Innovation Superclusters Initiative).

Mutually reinforcing entrepreneurial and innovation ecosystems

Sophie Veilleux, Fabiano Armellini and Carine Ferrey [81] rightfully suggest that as firms grow, the importance of the entrepreneurial ecosystem fades and that of the innovation ecosystem intensifies (see Figure 4-2). Start-ups and small businesses often focus on initial infrastructure, seed funding, and building diverse contact networks.[82] For example, entrepreneurs often collaborate with various ecosystem players without formally including them in strategic planning. This is often provided within the realm of incubators and accelerators. At this stage, the ambient entrepreneurial culture of the ecosystem strongly influences an entrepreneur's decision to aim for ambitious growth. Companies are born with or without the intention to grow, and this intention does not tend to change as the company develops. It is therefore important to create a culture that is favourable to growth at the grassroots level. For a company, growth is more often about visibility and influence on the world stage than about metrics like the number of employees. While some founders set aspirational revenue targets, not everyone does.

Once a company reaches medium size, its support needs evolve. It must now focus on stimulating innovation in product/service development and internal process optimisation – and this is where the innovation ecosystem begins to take over. Export support and help recruiting highly qualified employees also become increasingly important for expansion. Interestingly, medium-sized companies often 'give back' to their ecosystem through their innovations, high-value job creation, or contracts with other local businesses, including new ventures, hence keeping a foot in the entrepreneurial ecosystem. This creates a positive feedback loop, helping the entrepreneurial ecosystem thrive.

These two types of ecosystems are mutually reinforcing: innovation ecosystems may contribute to new businesses and thus stimulate the entrepreneurial ecosystem. Conversely, a dynamic entrepreneurial ecosystem may provide fertile ground for innovation experimentation and dissemination. The close integration of both entrepreneurial and innovation ecosystems, especially in terms of coordinated policies, is therefore important to avoid too many redundancies. Figure 4-2 exemplifies their relative importance as firms grow.

Strategic orientations and actions from public and academic institutions can significantly influence the vitality and effectiveness of entrepreneurial and innovation ecosystems. Beyond the usual suspects that provide an overall environment favourable to business and

innovation,[q] public authorities can launch initiatives to enhance the entrepreneur's image, promote local success stories, and encourage the next generation of entrepreneurs to ensure business sustainability. In Quebec, these for instance include Innovation Zones (*Zones d'innovation*), which are addressed below, that concentrate resources and skills to encourage synergies between businesses, universities, and research centres.

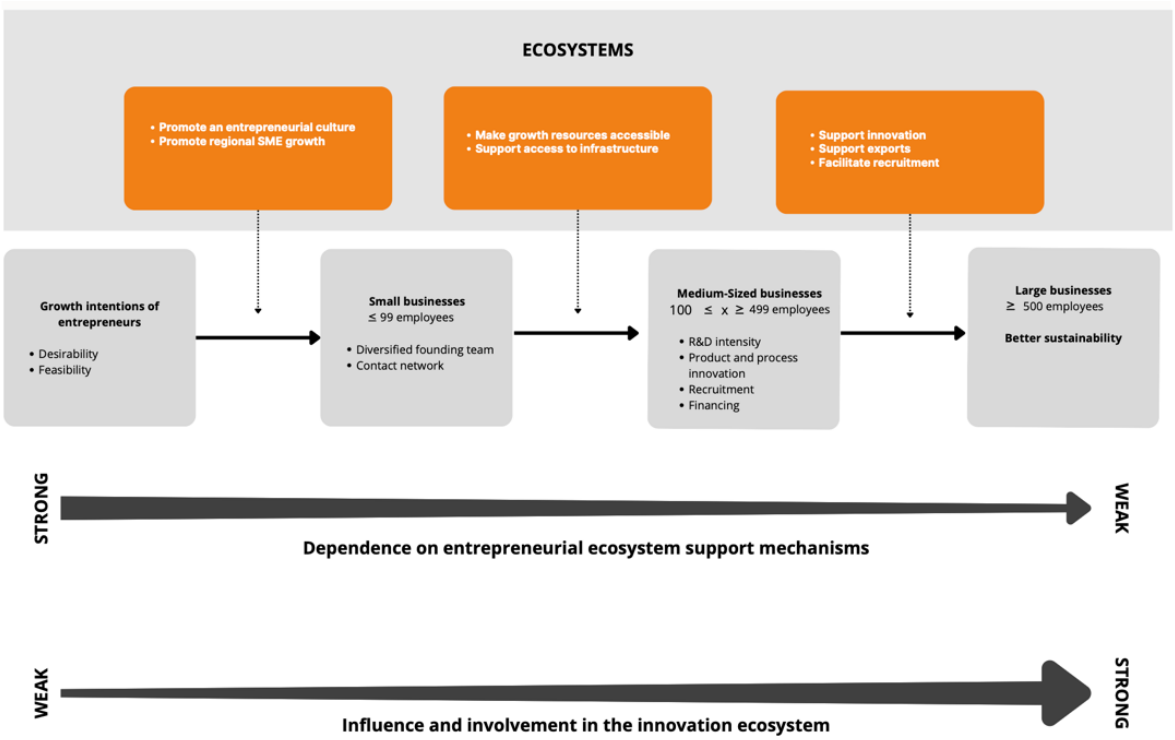


Figure 4-2 – The roles of ecosystems in business growth
Source: Adapted from the work of Sophie Veilleux, Fabiano Armellini, & Carine Ferrey [81]

Veilleux et al.[81] further add that growing entrepreneurs (medium-sized companies) feel neglected and little valued. The ecosystem does not pay much attention to their successes. Existing programmes are mainly for start-ups or large companies. Companies in between expressed a need to get together to discuss issues specific to businesses of their size. The authors therefore suggest that a public discourse emphasising stimulating objectives, focused on achieving international leadership and creating significant value could have a greater mobilising effect on entrepreneurs than purely quantitative objectives, especially when the ecosystem faces structural challenges like skilled labour shortages.

Enabling informed strategic decision-making, as explained in the previous chapter, requires that ecosystem performance and real impact be rigorously and continuously measured and assessed. We will address indicators and measurement frameworks in the next chapter. Effective ecosystem orchestration, even global orchestration, requires thinking beyond silos,

[q] For instance, these include predictable regulatory and fiscal framework conducive to entrepreneurial risk-taking and investment, simplification of administrative procedures, targeted subsidy programs, R&D tax credits, risk-sharing participatory loans, policies to attract, train, and retain a highly qualified workforce, and facilitating collaboration among ecosystem players.

and actively promoting synergies between research, entrepreneurship, and industry, to transform a region's scientific and technological strengths into concrete entrepreneurial successes and collective prosperity.

Policies for entrepreneurial ecosystems

In addition to the orchestration roles described in Chapter 2, other ecosystem actors take different roles. Canadian universities, the principal source of our national strength in S&T, play a triple role: scientific research, training the next generation of workers and researchers, and service to the community, loosely defined. Often called 'fourth mission', another of their roles aims to commercialise S&T and marketable ideas, and has been the focus of increasing attention. For example, entrepreneurship training, ranging from basic awareness to comprehensive graduate degrees, is now widespread across the country. The basic principle is that the more people are aware of entrepreneurial opportunities, the better.

> 'My goal with undergraduate students is not primarily to foster entrepreneurship in the sense of launching businesses. Instead, syntonising student antennas with opportunity – that's my objective.
>
> For graduate students, particularly PhD candidates, the approach is different. […] A specialised workshop is offered to PhD students whose research projects have potential commercial applications. Graduate students are considered more mature and often possess existing technological expertise that can be leveraged, and the emphasis is on building entrepreneurial capabilities around esta blished technological offerings.'
> — Fabiano Armellini (25 November 2021) *From Science to Entrepreneurship* [Webinar]
> www.4point0.ca/s/6989

Technology Transfer Offices (TTOs) play an important role in identifying good ideas that need to reach the market – and are increasingly involved in entrepreneurship training. However, they need to build trust with the student and academic community. As such, they should not compete with the various academic entrepreneurship programs, but could, for instance, offer complementary mentorship – collaboration is key. Then, once the good ideas have been filtered, incubators and accelerators can take over.

Economic development programs serve as broader mechanisms that align with innovation policies by enriching entrepreneurship, workforce development, and regional competitiveness. Initiatives such as regional development agencies and smart specialisation strategies attract investment and enhance regional industrial capabilities, often integrating innovation-driven models. Research and innovation intermediaries function as critical mechanisms within this landscape, acting as connectors that facilitate technology transfer, commercialisation, and collaboration between different stakeholders. These intermediaries include TTOs, industry liaison offices (ILOs), and innovation hubs that support businesses through services, i.e. intellectual property management and funding access.

> 'While there is no single solution to solve the lack of interest and capacity of small businesses to file for patents, it is possible to support them by planning and developing innovation subsidies that make the cost of patents affordable. Further studies are needed to examine the reason for very small

> firms' interest in trade secrets, and the role of innovation policies in supporting trade secrets while promoting open innovation practices.'
> — Nicolas Sacchetti [83]

Incubators and accelerators

While incubators and accelerators focus on helping start-ups in their initial phases, accelerators provide intensive, structured programmes aimed at rapidly scaling businesses. These programmes often integrate with incubators and technology transfer initiatives to enhance their impact.

Accelerators and incubators are vital components of the entrepreneurial ecosystem and serve as structured mechanisms for early-stage ventures, offering mentorship, funding opportunities, and industry connections. They provide early-stage companies with the support, resources, and mentorship needed to scale their operations and refine their business models. Furthermore, they can provide more practical information and networking opportunities, encouraging a collaborative environment where cutting-edge solutions can be developed and brought to market. This synergy not only accelerates technological advancements but also enhances the potential for significant economic impact. In a recent literature review, Emil Lucian Crișan et al.[84] identified the main outcomes associated with start-ups' participation in acceleration programmes. These intermediaries play a pivotal role in facilitating the validation of products or business concepts, expanding access to broader partner networks, and easing entry into new markets. They also contribute significantly to the development of entrepreneurial competencies, thereby enhancing the overall performance of start-ups. However, key performance indicators related to these outcomes are often difficult to produce, as they require longitudinal data and nuanced assessment. As a result, accelerators typically report on more accessible and quantifiable indicators, such as the number of start-ups supported, the volume of applications received, or the total amount of funding raised by the participating ventures.

Nevertheless, some research has drawn attention to the limitations of these intermediaries. While they are often praised for their role in supporting early-stage ventures, several studies highlight their limitations. For instance, Qiantao Zhang, Shiri Breznitz, and Steven Denney[31] show that firms that rely heavily on support from intermediary organisations, such as incubators and accelerators, do not necessarily experience better growth; in fact, too much participation in these organisations may hinder growth.

This finding challenges the common assumption that more support automatically leads to better outcomes for firms. Excessive reliance on such organisations can create a dependence that reduces a firm's ability to face market challenges, potentially weakening its competitiveness. A possible additional role for ecosystem orchestrators, moving away from dependence on financial resources, might be empowerment of member firms. A possible indicator of resilience would be the number or proportion of collaborative links that remain strong and active once project funding and other financial assistance has run out.

> 'The generosity of the GTA [Greater Toronto Area] ecosystem enables longer survival for some firms that lack core competencies in market competition... Policy makers might want to consider the balance between firm support services and letting low-quality firms survive market

> competition on their own.'
> — Qiantao Zhang, Shiri Breznitz, and Steven Denney (p. 1011)[31]

In some regions, there may be an embarrassment of riches in terms of incubators,[85] but this is not the case everywhere, as highlighted by Andrew Park et al.:

> 'Early translational support, development of the highly qualified personnel (HQP) and incubation of the science-based venture were critical to its future success. Yet too few universities and research agencies provide scientist–entrepreneurs and their nascent ventures with such support.'
> — Andrew Park, Azadeh Goudarzi, Pegah Yaghmaie, Varkey Jon Thomas, & Elicia Maine (p. 806)[86]

Entrepreneurial education

> In 1981, the late Professor Roger A. Blais proposed and then created the first industrial innovation initiation programme (P3I) in Canada aimed at 'stimulating entrepreneurship among the School's students and promoting technological innovation within Quebec SMEs.'[87] This entrepreneurship education program, initially called 'Complementary Orientation in Industrial Innovation,'[88] began in the fall of 1981 with 14 students. Having changed its name several times since then, this flagship programme continues to train approximately 55 students per year at Polytechnique Montréal.
> — Catherine Beaudry

To build and maintain sustainable entrepreneurial ecosystems, it is necessary to set strong foundations of knowledge, skills, attitudes and entrepreneurial thinking through entrepreneurial education. As such, entrepreneurship and education are intrinsically linked, forming a foundational duo that fuels innovative ventures and sustainable business growth. Entrepreneurial education programmes are capacity-building mechanisms that equip students and researchers with the skills needed for commercialisation, venture creation, and technology management. Sophie Veilleux explains the goals of the Université Laval entrepreneurship program:

> 'The aim is to develop entrepreneurial knowledge and skills within the university. We want to instil in students the desire to set up their own business, while providing them with the tools they need to identify and seize business opportunities. This type of training is beneficial to all businesses.
>
> We also aim to develop leadership skills, a culture of innovation and an international outlook. These skills will have a significant impact, not only on the companies created by these students, but also on Quebec's industrial sector as a whole.
>
> What's more, we offer our students support in the field of entrepreneurship. We encourage them to experiment within our partner companies and incubators, and we offer them initial support, as well as scholarships.'
> — Sophie Veilleux (24 February 2021) *Être ou ne pas être une licorne?* [Webinar]
> www.4point0.ca/s/1674

Such programs acts as catalysts that empower aspiring entrepreneurs with the necessary knowledge and skills to transform ideas into successful enterprises.[89] Entrepreneurship

education has been proven to have long-term effects on regional economic development, as graduates tend to start their ventures in the region where they completed their studies.[90]

Although entrepreneurship education, in general, positively influences firm creation, Shiri Breznitz and Qiantao Zhang[91] show that entrepreneurship education from incubators and accelerators has a stronger impact on firm establishment compared to university courses, especially for student entrepreneurship.

> 'Experiential learning, particularly within the lab setting, is crucial for graduate STEM students. This approach not only cultivates an entrepreneurial mindset but also facilitates the development of real-time commercialisation strategies, effectively bridging the gap between academic research and industry application.'
> — Elicia Maine, Professor, Simon Fraser University (25 Novembre 2021) *From Science to Entrepreneurship* [Webinar]
> www.4point0.ca/s/6989

Entrepreneurship education encompasses the development of specific skills. One obvious skill refers to the ability to pitch effectively, which is key to gaining trust and capturing the interest of potential investors and partners, as highlighted by Fabien Guimtrandy and Thierry Burger-Helmchen.[33] A well-delivered pitch not only showcases the entrepreneur's vision but also builds confidence in their capability to execute, creating a trust-based relationship essential for business success. As highlighted by Cruciata et al.,[92] a well-crafted digital pitch on the website of the start-up contributes to signalling, raising interest and attracting private investors.

Another essential skill for successful entrepreneurship is creativity. It fuels the generation of innovative ideas and distinguishes a venture in a crowded marketplace. A creative approach to problem solving and business strategy can lead to unique products and services that capture the imagination of consumers and create meaningful differentiation. University–industry collaboration may act as an informal temporal boundary spanning organisations, but regional policymakers should consider more formal policies in this regard as suggested by Arman Aksoy et al.:

> '[R]egional policy makers intending to use universities as an engine for innovation and regional economic growth should consider policies and initiatives aimed at bridging the cognitive gap between university and industry by either increasing technological proximity or reducing cognitive distances by financing boundary spanning organisations.'
> — Arman Aksoy, Davide Pulizzotto, & Catherine Beaudry (p. 1)[93]

Invention to Innovation (i2I), founded by 4POINT0 member Elicia Maine, is the perfect example of a mechanism that aims to bridge the gap between knowledge ecosystems and business ecosystems by leveraging the power of entrepreneurial and innovation ecosystems. A suite of programmes dedicated to STEM[r] graduate students and postdoctoral fellows who want to increase the impact of their research through innovation and

[r] Science, Technology, Engineering, and Mathematics

entrepreneurship, i2I has garnered international recognition for creating transformative change.

In collaboration with the national research and innovation organisation Mitacs and in partnership with Queen's University in Eastern Canada and Memorial and Dalhousie universities in the Atlantic, the i2I programme has expanded to over 20 Canadian universities in the last three years. The organisation has co-created a hybrid version of the programme for interns and graduates nationwide: Mitacs i2I Skills Training (see Box **4-1**).

> 'i2I is about when you take your specific invention, the attributes that you're creating in the research lab, and you commercialise that in the world.'
> — Elicia Maine, cited by Nicolas Sacchetti [94]

Box 4-1 – Invention to Innovation (i2I): Bridging research and impact

Invention to Innovation (i2I) is a multifaceted initiative dedicated to closing the gap between academic research and societal impact. Launched in 2015 at Simon Fraser University, i2I plays a vital intermediary role in Canada's innovation ecosystem by equipping researchers, scientists, and graduate students with the entrepreneurial and strategic skills needed to transform ideas into tangible innovations.

Through a combination of specialised programs, i2I connects academia with industry, investors, and policymakers across Canada, fostering collaboration and knowledge transfer. Participants engage in structured learning, mentorship, and real-world application, gaining expertise in commercialisation, business strategy, and market integration. This approach ensures that research discoveries do not remain in silos but are effectively translated into technologies, products, or services with real-world relevance.

The impact of i2I extends far beyond individual participants. Alumni have launched successful start-ups, commercialised groundbreaking technologies, and contributed to interdisciplinary collaborations, strengthening Canada's innovation pipeline. As an intermediary, i2I not only supports the development of 'scientist-entrepreneurs' but also facilitates the critical connections needed to integrate innovation across sectors.

For instance, i2I aims to open up different career paths for science students who seek a career path outside of academia. Programme participants are introduced to the vocabulary and perspectives of industry. With additional skills and understanding, it is easier for them to start their own businesses or work in industrial research centres, companies, governments or non-profit-organisations (NPOs) that support business creation and innovation. The programme is not aimed solely at business start-ups, but rather towards the mindset of impact research.

By acting as a bridge between research and implementation, i2I advances Canada's capacity to build a dynamic, inclusive, and globally competitive innovation ecosystem. It exemplifies the transformative potential of fostering collaboration and creating pathways for research to drive meaningful change.

— Arman Aksoy

STI policies and programmes

Policies and programmes shape innovation ecosystems through their interconnectedness. Policies establish the strategic direction, setting priorities, funding structures, and regulatory frameworks to promote innovation. Programmes, in turn, serve as the operational tools that implement these policies, ensuring their practical application through funding programmes, collaborative initiatives, and institutional support structures. For instance, institutions like the National Research Council (NRC) play a crucial role by funding applied research, facilitating industry partnerships, and accelerating technological innovation in high-impact sectors.

Effective alignment between policies and programmes ensures that innovation ecosystems function cohesively, translating policy objectives into tangible economic and societal impacts. Steven Denney, Travis Southin and David A. Wolfe [95] provide a detailed overview of the innovation policy mix at the disposal of Canadian businesses. The authors highlight the perfectly understandable preference of scale-up entrepreneurs for 'direct grants over tax credits'. The perception of the entrepreneurs interviewed is that the 'one size fits all' policy mix is misaligned with their needs.

> 'With distinct policy preferences rooted in their growth experiences specific to the country's political economy, […] scale-up entrepreneurs prefer a more active role of the government in the form of demand-side, direct, and targeted innovation instruments.'
> — Steven Denney, Travis Southin, & David A. Wolfe (p. 858)[95]

> 'Interviewees noted that government grants help the firm grow while staving off pressure to dilute equity ownership. One entrepreneur noted that "the things that you want to finance your firm with are real customers, then grant money, then external capital, in that order"'.
> — Steven Denney, Travis Southin, & David A. Wolfe (p. 865)[95]

University–business collaboration programmes serve as key mechanisms to bridge academic research with industry needs. These initiatives include knowledge transfer partnerships, collaborative research grants, and industry-led innovation challenges. Programmes like Mitacs and a number of Tri-Council initiatives in Canada provide structured support for academic–industry partnerships, helping to translate research into organisational or commercial applications. But innovation does not stand on the shoulders of universities alone, rather it is firms and the various ecosystems that surround universities that largely drive innovation and its impact.

Created through a substantial grant from the Canada First Research Excellence Fund (CFREF), the TransMedTech Institute exemplifies a typical integrated STI policy aiming to bring together academia and industry to foster innovation (see Box **4-2** for details).

Box 4-2 – TransMedTech Institute: A model ecosystem for innovation in medical technologies

The TransMedTech Institute, based in Montreal, is a leading example of an innovation ecosystem designed to accelerate and de-risk the development of medical technologies (medtech). Its unique Living Lab model fosters collaboration among researchers, clinicians, industry partners, and patients, creating a dynamic environment where

groundbreaking ideas are transformed into impactful solutions that address critical healthcare challenges.

A structured innovation ecosystem

At the heart of the Institute's success is the trademarked TransMedTech Method, a structured framework that guides the entire innovation process. Aligned with the ISO 13485 standard for medical device quality management, this method includes every step from identifying clinical and patient needs to co-developing solutions, navigating regulatory pathways, and assessing real-world impact. By integrating transdisciplinary expertise across engineering, medicine, data science, and social sciences, TransMedTech ensures that innovations are not only technically robust but also aligned with user needs and clinical realities.

Addressing key healthcare needs

The Institute focuses on developing technologies that respond to major challenges in the healthcare ecosystem. These include digital health technologies (telehealth, remote monitoring), personalised diagnostics and care, advanced surgical tools, and innovations in regenerative medicine and biofabrication. This targeted approach ensures that TransMedTech contributes meaningfully to improving patient outcomes and addressing the evolving demands of healthcare systems.

The Living Lab approach

The Living Lab model is the cornerstone of TransMedTech's collaborative ecosystem. By actively involving patients, clinicians, and other stakeholders in the development and validation of technologies, the Institute ensures that solutions are practical, user-centred, and ready for implementation. This participatory approach reduces the gap between research and real-world application, accelerating the translation of innovation into impact.

Building a global medtech hub

TransMedTech is not only advancing health technologies but also establishing Quebec as a global leader in the medtech sector. By creating an environment that supports collaboration, structured innovation, and stakeholder engagement, the Institute drives the development of transformative solutions while fostering economic growth and training the next generation of healthtech innovators.

In essence, TransMedTech exemplifies how a structured and collaborative innovation ecosystem can address pressing healthcare needs while accelerating the journey from concept to clinical and commercial success.

— Carl-Éric Aubin

By integrating these various mechanisms into their support processes, innovation ecosystems become more dynamic, interconnected, and capable of transforming scientific and technological advancements into meaningful economic and societal impact.

These programs and institutions should provide the right boost to drive S&T towards innovation and to move the dial towards more impactful innovation.

Navigating the sea of programmes

Firms and organisations benefit significantly from these policies and programmes, gaining access to funding, supporting collaborations, and accelerating commercialisation efforts. R&D tax credits and research grants act as financial mechanisms to reduce the risks of investing in innovation, while university-industry partnerships function as knowledge transfer mechanisms to streamline technology commercialisation and workforce development. Unfortunately, navigating through the numerous initiatives is still relatively complex, as highlighted by Loïck Gautier from the *Conseil de l'innovation du Québec* at the 2nd P4IE[s] Conference in May 2022:

> 'The need for data centralisation and to ease access to programs and subsidies to companies caught my attention. Right now in Québec there are quite a lot of programs, from the provincial and federal. But it is generally difficult for a company to get help. For every program, you must fill in a different form.'
> — Loïck-Alexandre Gautier, cited by Nicolas Sacchetti [96]

This is where the role of innovation intermediaries, embedded in innovation ecosystems, is essential. They help firms, especially start-ups and small businesses, identify and apply for the right programmes. Innovation intermediaries act as guides and mentors for SMEs. In parallel, accelerators and incubators serve as growth mechanisms, enabling start-ups to scale efficiently, while innovation clusters and zones operate as strategic mechanisms that provide networking and infrastructure advantages.

> Medium firms are often left to their own devices – too big to qualify for the guidance of certain intermediaries, incubators and accelerators, but too small to have the sufficient resources to scout out and apply for the right programmes.
> — Catherine Beaudry

Charlotte Laramée, ex-Vice President of Operations at Aéro Montréal, mentioned that their research report highlights the misalignment of current government programmes with industry needs for promoting technologies to potential clients, specifically for Remote Piloted Aircraft Systems (RPAS).[97] Her study also reveals that Quebec lacks pre-commercialisation support for Technology Readiness Levels 7 to 9.

Very recently, a step in the right direction was announced in the Quebec provincial budget for 2025. A new simplified tax credit for research, innovation and commercialisation (CRIC) will replace eight other programmes.[t] This should contribute to reducing the application

[s] Policies, Processes, and Practices for Performance of Innovation Ecosystems (P4IE) conference.

[t] https://www.finances.gouv.qc.ca/Budget_and_update/budget/documents/Budget2526_InnovatingToProsper.pdf

burden. More importantly, the new CRIC tax credit covers the pre-commercialisation activities that are vital to the commercialisation of innovation.

Specific policies to build and sustain innovation ecosystems

Several ecosystem-specific programmes initiated prior to the pandemic, for instance, the Innovation Superclusters Initiative (ISI) and Quebec's Innovation Zones (*zones d'innovation*), were examined by the 4POINT0 team, but it is far too early to assess whether these policies had the desired impact. Most of these policies target highly innovative technologies, for instance, quantum computing, that have yet to reach their full capacity.

From 'Innovation Superclusters' to 'Global Innovation Clusters'

The Innovation Superclusters Initiative, renamed Global Innovation Clusters since the second round of funding, operates as a large-scale innovation programme, enhancing cross-sector collaboration between industries, academia, and government. These clusters create 'technology-focused' innovation ecosystems, bringing together firms, researchers, and policymakers to drive advancements in fields such as AI, advanced manufacturing, and life sciences. The programme announced in the 2017 federal budget was designed to be much more than large clusters of clusters or 'more connected' clusters. One of the main architects of the programme, John Knubley,[98] mentions that they were considered a 'fresh type of innovation policy' (p. 5) for Canada, as a number of other countries had successful cluster creation and support programmes.

> 'The Innovation Superclusters Initiative is a $950 million programme designed to address innovation and scale-up challenges in Canada. This programme involves co-investment with industry, and its key focus is fostering collaboration between anchor firms, large and small enterprises, and other ecosystem players, such as academia and non-profit organisations. The goal is to establish Canada's competitive advantage in the five key areas targeted by the superclusters.'
> — Barbara Gibbon, Director General, ISED (19 November 2020) *Novel innovation indicators: Exploring approaches, uses and challenges* [Webinar]
> www.4point0.ca/s/1385

> 'A high-performance IE (innovation ecosystem) enables an economy to assimilate or develop technologies in order to increase industrial productivity. As such, IEs play a key role in promoting national and regional competitiveness, as well as innovation and growth, as outlined in Canada's Innovation and Skills Agenda.'
> — Manassé Drabo, Research analyst, Statistics Canada (28 September 2023) *Innovation ecosystem performance indicators: Review of the literature* [Webinar]
> www.4point0.ca/s/5185

The Innovation Superclusters Initiative programme was intended to function as a targeted mechanism for regional innovation, offering tailored support for high-tech industries, start-ups, and research-intensive firms. Often established through public-private partnerships, these superclusters provide businesses with innovation incentives (e.g. funding for projects), infrastructure support, and access to specialised research facilities, strengthening localised

innovation ecosystems. In reality, as David Wolfe et al. suggested, the programme was essentially used as a 'mini granting agency':

> 'The innovation superclusters initiative, launched in 2018, was a confused piece of public policy from the outset. […] If there was a cluster aspect, it was at best a minor add-on to a program primarily focused on funding industry-led research projects, as it effectively turned each of the superclusters into a mini granting agency.'
> — Daniel Munro, Darius Ornston, & David A. Wolfe[99]

Peter Phillips further suggested that the programme would benefit from a 'whole-of-government' approach to be able to deliver on its promise:

> '...the federal government may need to make good on its promises to align their other activities with these ventures. A "whole-of-government" approach to supporting these superclusters would suggest that many parts of the system—e.g. regulators, infrastructure investments, policies and programs at the federal, provincial and municipal level—should become more responsive to the needs of these ventures.'
> — Peter Phillips (p. 2)[100]

The second round of funding, transforming the programme into Global Innovation Clusters, partially remedied this flaw by reassessing and refining the programme for greater competitiveness. This 'shift to a more experimental governance approach'[99] prioritises evaluating past outcomes and adjusting programme design to better support Canadian firms' innovation.

As will be explored in the next chapter, a complete and appropriate evaluation frame has yet to be fully developed and deployed for such a novel policy. For instance, as large clusters comprised of smaller clusters, these global or superclusters require global orchestration (see Chapter 2), which calls for an appropriate measurement framework (see Chapter 5). Researchers such as David Doloreux and Anthony Frigon [34] indeed suggest that clusters cannot be evaluated without considering their connectedness within larger networks. This adds a level of complexity to the measurement frameworks that must be put in place by the global orchestrators and the teams responsible for managing these innovation support programmes, etc. In the next chapter, which focuses on indicators, we will explore some of these challenges. The authors will also touch on the issue of supercluster impacts being limited to the large urban regions where most of their activities take place.

> 'Individual clusters cannot be assessed in a vacuum, but rather as embedded in networks transcending their geographical and sectoral boundaries.'
> — David Doloreux & Anthony Frigon (p. 153)[34]

Furthermore, Doloreux and Frigon, cited above, found no evidence that interregional collaboration mechanisms were appropriately addressed in the design stages of the Innovation Superclusters Initiative. As interfirm collaboration often occurs between firms and their suppliers, equipment providers, customers, or even their competitors, addressing this issue is specifically important for boosting innovativeness within supply chains.

> 'There is a lack of collaboration between initiatives in Eastern and Western Canada. However, if we facilitate this collaboration, it will position the

> country as an industry leader and better promote Canadian technologies internationally.'
> — Charlotte Laramée, ex-Vice President of Operations at Aéro Montréal, cited by Nicolas Sacchetti [97]

In the current geopolitical context, both governments and businesses acknowledge the need to remove existing barriers to inter-provincial trade. Once these hurdles are reduced, inter-provincial collaboration between firms and their supply chain partners will likely be facilitated. In parallel, it is imperative to seriously address interregional collaboration, in both policy and practice, in order to boost Canadian co-innovation. These unprecedented times may trigger the 'whole-of-government approach' suggested by Peter Phillips above, to which we would add the need for strong global orchestration of Canadian ecosystems.

In the final selection of five superclusters, a few sectors were left behind, notably the aerospace sector. Despite a strong application, the proposed Mobility Systems and Technologies for the 21st Century (MOST21) Supercluster, driven by key organisations in the aerospace industry, did not make the final cut. This 'wannabe' supercluster was deemed too well organised by the Government. So what type of policy would then be appropriate for such a 'natural cluster', as stressed by Suzanne Benoît, who was at the helm of Aéro-Montréal for several years, i.e. one that exists without having needed a specific policy mechanism to emerge or to thrive?

> 'The strength of the Greater Montreal aerospace cluster, Aéro Montréal, is largely due to the fact that it is what I would call a 'natural cluster' that has reached a high level of maturity.
> The role of Aéro Montréal, the cluster's secretariat, has been to mobilise this 'natural' ecosystem around the issues and challenges facing the sector, and to find ways of improving the competitiveness of businesses. '
> — Suzanne Benoît, President and CEO, Association québécoise du transport aérien (and former CEO of Aéro-Montréal)

In such a high technology yet mature sector, specific policies are indeed required to foster a deep transformation of the industry towards sustainability. As this will likely involve new actors in the ecosystem and interactions with other ecosystems, both orchestration and innovation commons are essential (see Chapter 2 – Further information). The policies should favour the creation of such experimentation spaces and the emergence of innovation ecosystems, as explained by Cohendet et al.:

> 'The local innovation commons emerge as a complementary institutional context related to those already existing in the locality: accelerators, incubators, fundraisers, and so on, on one side, and formal companies (big and small), on the other. The first are not always capable of supporting projects with such an uncertain output partly due to the lack of legitimacy of project holders. The second consider that market opportunities are too uncertain to engage internal resources in such a risky project.'
> — Patrick Cohendet, David Grandadam, & Raphaël Suire (pp. 8-9)[22]

Large established aerospace companies lacked the incentives and market opportunities to venture into creation of a more sustainable aircraft or industry. Moreover, the traditional local institutional organisations were never in a position to support such greening projects. The Quebec government stepped in with 'Mobilising Projects'.

Quebec's 'Mobilising Projects' to launch innovation ecosystems

Quebec's 'Mobilising Projects' (*grands projets mobilisateurs*) arose from an industrial initiative launched around 2008-2009, aimed at obtaining government support to bridge the gap between applied research (technology readiness levels or TRL 1 to 3) and commercialisation (TRL 4 to 7), often described as the 'valley of death'. This critical phase, marked by high levels of investment and risk, has led the government to recognise the need for structuring support. In the 2010-2013 Quebec Research and Innovation Strategy (QRIS),[u] five mobilising projects were proposed: the ecological airplane; the electric bus of the future; the forest biorefinery, the Ecolo-ICT; and a fifth, announced later, PARC (Pairing Automated Resource Sharing in Communities).[v] In Box **4-3**, Dominique Sauvé, CEO of OIDS[w] explains the genesis and evolution of the first two of these projects (which led to the creation of SA²GE[x] – Cutting-edge aeronautical systems for the environment, and to Lion Electric) and the role of the former in shaping the innovation ecosystem around the ecological airplane.

Box 4-3 – Dominique Sauvé's (OIDS) perspective on Quebec's 'Mobilising Projects'

The first projects, such as SA²GE in aerospace, were approved in 2010. At the time, these were one-off initiatives, outside any formal programme, aimed at bringing technological innovation closer to commercialisation. The positive evaluation of this first phase – in terms of relevance, effectiveness and efficiency – led to its renewal and the extension of the model to other sectors. It was only after several cycles that the government formalised the approach within a coherent programmatic framework.

Government support

Industrial investment, in particular through the provision of equity capital equivalent to or greater than government aid, remains a central indicator of perceived potential. In addition to this financial objective, there are technological goals – for which demonstration or even failure can be a valid outcome – as well as, in the early rounds, strong environmental considerations.

In addition, the government played a mobilising role by demanding that spin-offs benefit Quebec SMEs, universities and research centres. While collaboration between partners was initially relatively low on the agenda, it has become increasingly important over time. Today, projects require at least two partners to actively share costs, with a minimum contribution of 20% for the minority partner, thus consolidating genuine technological cooperation.

The need for efficient coordination

[u] SQRI for *Stratégie québecoise de la recherche et de l'innovation 2010-2013*.
[v] L'avion écologique, l'autobus électrique du futur, le bioraffinage forestier, Écolo TIC, and Partage Automatisé des Ressources dans des Communautés.
[w] Open Innovation D. Sauvé – *IODS, Innovation Ouverte D. Sauvé*.
[x] SA²GE for *Systèmes aéronautiques d'avant-garde pour l'environnement.*

To ensure effective governance, the government required the creation of non-profit organisations in which industry holds the majority of seats on the board of directors. These entities, which sign agreements with the government, assume responsibility for projects. However, the government retains a central role in managing the calls for projects, guaranteeing a neutral and transparent selection process.

Given their limited duration and the complexity of the skills required, organisations prefer to use an external team rather than set up a permanent in-house structure. In this context, OIDS (Open Innovation D. Sauvé Inc.) acts as a third party specialised in project coordination. OIDS monitors collective objectives, compiles relevant data and supports governance by adapting actions to realities on the ground, particularly when adjustments are required.

Great expectations

During the course of a project, the government expects companies to rigorously execute the projects, to be transparent about any difficulties encountered, and to be adaptable, given the uncertainty inherent in R&D activities spread over several years. In return, companies expect a certain degree of flexibility from the government, particularly when it comes to absorbing unforeseen financial and scientific events. Once the projects are completed, the government hopes that the spin-offs will be marketed and that the partnerships forged, particularly with SMEs and research centres, will be maintained. Companies, for their part, are looking for predictable, long-term support to turn their technology roadmaps into reality.

Two contrasting examples

To highlight different ways that the collaborative model can be applied and to better illustrate the complex reality of this programme, we will compare two mobilising projects: the eco aircraft proposed by SA²GE, and Lion Electric Company, renowned for its electric schoolbus.

For Lion, the focus was on developing platforms for electric buses and heavy-duty vehicles. Two projects were successfully completed before 2024. A third, undertaken more recently, was halted when Lion filed for protection under the Companies' Creditors Arrangement Act in December 2024. These initiatives were managed by separate organisations, dissolved at the end of each project. The partnerships were mainly composed of SMEs, including Lion itself, which was still an SME at the start of the first project. The companies often outperformed, seeing the projects as a major opportunity for growth and structuring.

In contrast, the SA²GE project, focused on greener aviation, emerged from initiatives led by major prime contractors and equipment manufacturers. It is based on a single organisation, still active today, which brings together a vast and diversified technological portfolio covering several aeronautical segments (fixed-wing aircraft, helicopters, airships, drones, etc.). This organisation has hosted successive projects under the name SA²GE, a name which also designated the first projects, and today oversees some ten projects simultaneously.

It is therefore difficult to draw a direct comparison between the two ecosystems. SA²GE presents an integrated and diversified approach, oriented towards the parallel advancement of multiple technologies. Lion projects are targeted demonstrators, led by SMEs with strong execution capabilities.

Despite these differences, the foundations of the mobilising model remain constant: shared objectives, a board of directors dedicated to achieving collective targets, and structured support. SA²GE's success can be attributed in particular to its technological diversification, which enables several innovations to progress within a collective welded by similar objectives – even if each partner may occasionally encounter difficulties in its work.

The need for better measurement frameworks

The main challenge for these projects lies in their sustainability and the measurement of their impact. To date, objective data are not systematically available to the government, which weakens the ability to demonstrate the real benefits of public investment, particularly in a context of budgetary constraints. Another important lesson concerns the gap between technological development and commercialisation, which requires distinct skills. Although projects have often been successful in terms of innovation, the transition to the market remains an area of fragility. Integrated commercial support from the earliest stages would better prepare companies for this transition.

Innovation needs stability

Finally, several complementary issues need to be highlighted: the importance of predictability in government support, the ability of competitors to collaborate, the management of sensitive information, and the role of the orchestrator – traditionally provided by the government, but whose limitations invite us to consider greater orchestration by the ecosystem itself. Inter-provincial and federal collaboration should also be an important lever for strengthening the overall impact of these initiatives.

— Dominique Sauvé, CEO of OIDS

In essence, Dominique Sauvé and her team play a supporting role for the orchestrator, by fostering collaboration and sharing ideas and knowledge, in order to bring new innovations to market. As such, OIDS contributes to the establishment of the same kind of innovation commons suggested by Cohendet et al.:

> '[T]he nature of the institutional arrangements is essentially twofold. On one side, there are institutional arrangements destined to pool local resources and to equip the local platforms of interactions (the components of the middleground) with rules and norms to efficiently function in order to facilitate the connections between members and their mutual learning experience. On the other side, there are institutional arrangements destined to facilitate the transformation of ideas discussed and exchanged in the local commons into novelties, innovative outputs, prototypes, up to the formation of start-ups.'
> — Patrick Cohendet, David Grandadam, & Raphaël Suire (p. 9)[22]

Dominique Sauvé emphasises the strategic relevance of mobilising projects to stimulate innovation and structure partnerships in Quebec. Having contributed to managing several rounds of projects, her insight on the rules and norms is invaluable. She calls for improved impact assessment (to be addressed in the next chapter), greater predictability of public support, stronger support for commercialisation, and a progressive redefinition of the role of orchestration (covered in Chapter 2), all of which are necessary conditions for the sustainable vitality of the innovation ecosystem.

Quebec's Innovation Zones

About a decade after its Mobilising Projects, and a couple years after the announcement of the five Superclusters, the Quebec government launched its Innovation Zones (*Zones d'innovation*) programme to create world-class ecosystems that stimulate the commercialisation of innovations, increase exports, attract local and foreign investments, and enhance business productivity. Four Innovation Zones have been announced so far (DistriQ in Sherbrooke, Espace Aéro at multiple sites in Greater Montreal, Technum Québec in Bromont and *Vallée de la transition énergétique* in Mauricie). The zones encourage cooperation between the private sector, public sector, academic institutions, and research centres to develop innovative projects in advanced technology sectors where Quebec has competitive advantages. They are designed to be engines of economic growth, technological development, and environmental sustainability. In addition to industrial and research activities, they offer a diverse, attractive and dynamic living environment that enhances the well-being of residents and workers. Without the latter characteristic and their strong geographical anchor, their goals regarding increasing economic impact of innovation are relatively similar to those of the Global Innovation Clusters.

These zones are designated territories where talents, entrepreneurs, major industry players, and researchers converge, fostering collaboration between various socioeconomic stakeholders such as businesses, economic development organisations, research and educational institutions, and municipalities. In contrast to the Global Innovation Clusters, the Innovation Zones are located in specific territories that facilitate interactions and synergies among different players. Even if some are located on several sites, they are relatively close to one another. For instance, *EspaceAéro* has centres in Mirabel, St-Laurent and Longueuil, while *Vallée de la transition énergétique* spans Trois-Rivières, Shawinigan and Bécancour, each with a distinct technological specificity.

During a day of conferences and discussions on Innovation Zones, Catherine Beaudry stressed how essential it is to establish trust between the different actors in these zones:

> 'If there isn't a climate of trust [...] at the base of the innovation zone, it won't work.'
> — Catherine Beaudry (29 January 2020) *Launch of Quebec's Innovation Zones Programme*

Without it, no collaboration will last, and the ecosystem will crumble. In order to ensure trust and symbiotic relationships within the ecosystem, it is the role of the orchestrator (see Chapter 2) to design an appropriate governance system for the ecosystem, while the role of the government is to provide well-crafted public policies regarding IP and innovation. If either

fails, it seriously jeopardises the cohesion and future impact of the ecosystem. As highlighted earlier by Dominique Sauvé (see Box **4-3**), an appropriate measurement framework with clear objectives and indicators is absolutely necessary to provide goals that are clear and accepted by all actors of the ecosystem. This is addressed in the next chapter.

Conclusion

All the policy examples presented above recognised and demanded a strong involvement of small and medium-sized enterprises (SME), and in some cases, led to the creation of new ventures, some of which emanated from universities and university–industry collaborative projects. The role of entrepreneurial ecosystems is thus likely to be closely embedded in that of innovation ecosystems and their global orchestrators. It is however important to recognise that support, and the roles of the various ecosystems, need to evolve as firms grow.

Our research suggests a few avenues for improvement in the design and delivery of STI policy, to foster innovation and benefit from entrepreneurial and innovation ecosystems. In respect to government support, significant confusion and an excess of red tape remain, but this is widely acknowledged and steps in the right direction are being taken.

With a few exceptions (e.g. Quebec's Innovation Zones and Mobilising Projects), most high-level programs (including the super/global innovation clusters) do not build on the strength of local/regional innovation ecosystems. That said, as the country moves towards a pan-Canadian supply chain and trade approach, Canada-wide programmes, and inter-provincial collaboration may prove essential for coordination purposes.

The next chapter will argue for the need to co-develop a logic framework and associated indicators to assess the path towards impact at the same time as policy is being designed. This is no trivial matter, as policies must account for the needs of local/regional ecosystems while simultaneously fostering inter-provincial collaboration.

Chapter 5
Innovation Ecosystem Performance

Catherine Beaudry

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> ‘I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.’
> — Sir William Thomson, 1st Baron Kelvin, (pp. 73-74)[101]

> Data and indicators without storytelling and context are often meaningless; Hence the will in 4POINT0 to combine quantitative and qualitative analyses using the power of big data analytics.
> — Catherine Beaudry

Introduction – The measurement challenges

Measuring the performance and impact of innovation ecosystems is a complex challenge that continues to puzzle academics, policymakers and innovation ecosystem orchestrators. While it is relatively easy to assess geographically bound entities such as regional or national innovation systems and clusters, innovation ecosystems are another story. With their characteristic fuzzy boundaries, formal and informal network relationships, and intersectoral collaborative attributes, evaluation of innovation ecosystems is no trivial undertaking.

The next paragraphs explore for whom these measurements are important, where the geographical boundaries of these metrics lie, when indicators are available and needed, and what should be measured, while the rest of the chapter focuses on the how.

For whom

Measuring the health and performance of an innovation system is a multifaceted task that begins with understanding and visualising[y] the innovation ecosystem. This initial hurdle involves considering not only the geographical aspect, such as the cluster or regional innovation system, but also the collaborative innovation network dimension, the role of the supply chain, and the national and international contexts. This mapping serves as a foundation for systematically assessing performance through a set of carefully defined indicators that capture the ecosystem's multidimensional nature. Then, we must establish for whom the indicators are built and for what purpose. For instance, for companies, the Key Performance Indicators[z] (KPIs) that matter most will pertain to their own performance, emphasising the economic dimension and increasingly, socioenvironmental concerns. These metrics are often used to internally evaluate business objectives and operational efficiency.

Where

For governments, the performance indicators that matter most will be those related to the portion of the innovation ecosystem that sits on their territory. For instance, for the ENCQOR 5G[aa] consortium spanning the Quebec–Ontario corridor, the Government of Quebec would be interested in the performance of firms within its provincial borders.

The impact measurement frameworks used to evaluate different government programmes may include some KPIs or equivalent indicators spanning several regions or provinces. Programme administrators will therefore want to isolate the specific effects of their programme from other impact factors.

For the ecosystem, the relevant KPIs or equivalent measures will encompass all of the organisations that gravitate within its remit, directly and indirectly, both locally and internationally. Therein lies the complexity.

When

Initiating a new project, creating a new government innovation support programme, or building an emerging innovation ecosystem requires establishing clear objectives and specific metrics to evaluate progress from the outset. Throughout the project or programme, monitoring the progress of these indicators helps track progress. Logical frameworks are typically used for this purpose. Upon finishing a project, an impact measurement framework is often implemented.

One of the main problems encountered when implementing these measurement frameworks is the lack of up-to-date data and geographical coverage that is often deficient at the subregional level.

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[y] Chapter 2 on orchestration presents a few mapping methods.
[z] Key Performance Indicators (KPIs) are precise, numerical measures that track progress towards established organisational performance objectives linked to innovation initiatives.
[aa] ENCQOR 5G is described in Chapter 2.

> Often, the data is not up to date, being a few years old, and the quantity of data collected by national statistical offices does not allow for representative samples of municipalities or Regional County Municipalities (RCMs). It is therefore impossible to adjust policies and programmes in real time, or to adapt them to sub-regional realities.
> — Catherine Beaudry

What – Measuring shared value

Another challenge relates to accurately assessing the shared value (SV) that innovation ecosystems aim to create. This value increasingly includes not only economic performance, but also social and environmental aspects. Neither firms, governments, nor ecosystem orchestrators are well equipped to build the necessary framework for measuring innovation ecosystem performance, in part due to the lack of data, and the challenges associated with collecting, integrating, and analysing data from multiple sources.

> 'Shared value (SV) creation [is] defined as the strategic processes and policies in support of pursuing economic returns while solving societal issues, which are not generic, but closely aligned with the core business of an entity.'
> — Giulia Piantoni, Laura Dell'Agostino, Marika Arena, & Giovanni Azzone (p. 191)[19]

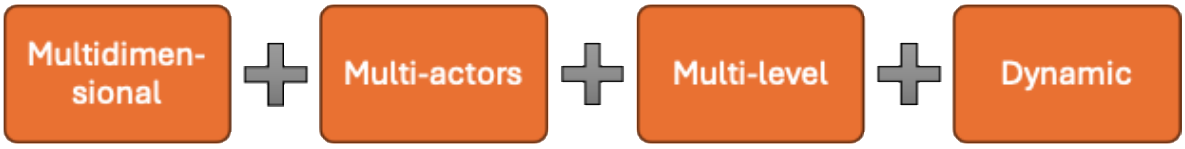
Furthermore, innovation ecosystem orchestrators need to have in their sights the value captured within business ecosystems from the value that innovation ecosystems have created. As a consequence, it is often difficult to disentangle value created from value captured. For instance, while innovation ecosystems might focus on the number of innovations introduced in the past three to five years, or the proportion of sales that stem from innovation, business ecosystems will capture the value of these innovations for a longer period, i.e. once they are no longer considered innovations (about five years depending on the industry).

> 'Value is therefore an implicit goal of innovation, but cannot be guaranteed on an ex ante basis because innovation outcomes are uncertain and heterogeneous. […] Value-related measures are thus important for understanding the impacts of innovation, although there is no single measure of economic or social value in established statistical frameworks such as the [System of National Accounts – SNA].'
> — OECD (p. 47)[102]

As highlighted by Piantoni et al.,[19] it is particularly complex to measure the collective or shared value created in innovation ecosystems, due to its multidimensional, multi-actor, multi-level and dynamic nature (see Figure 5-1). Both shared value measurement and ecosystems are highly complex; we have no choice but to define their scope.

> 'Measuring SV created in IEs is particularly complex, due to the multidimensional, multiactor, multilevel and dynamic nature of IEs (and of SV [shared value] creation, too).'
> — Giulia Piantoni, Laura Dell'Agostino, Marika Arena, & Giovanni Azzone (p. 191)[19]

Figure 5-1 – Characteristics of innovation ecosystems that complexify measuring the shared value created



Source: Piantoni et al.[19]

How – New data

For these reasons, neither researchers nor ecosystem orchestrators can come up with a perfect measure, or sometimes even an adequate one. A single indicator will never be sufficient, and will obviously be imperfect because it cannot cover all ecosystem stakeholders or dimensions. A further challenge arises from survey overload and questionnaire fatigue. It is indeed increasingly difficult to obtain responses from organisations, as every purchase and service these days is followed by a satisfaction survey. Spam filters often filter out solicitation emails, and many that make it to the target inbox are simply deleted by potential respondents.

> '…the number of low-cost web-based surveys sent to firms has sky-rocketed to the extent that obtaining a representative response rate has plummeted to lower than 5–10% in most cases. […] Alternative or complementary to these sources are web-based unstructured textual data. The increasing amount of data available in the form of digitalized text indeed offers new avenues for innovation studies.'
> — Pietro Cruciata, Davide Pulizzotto, & Catherine Beaudry[103]

To build a complete picture of the performance of innovation ecosystems, we therefore need to use a panoply of traditional and novel indicators built from administrative data, quantitative and qualitative methods, as well as traditional text mining techniques and generative AI-based tools.

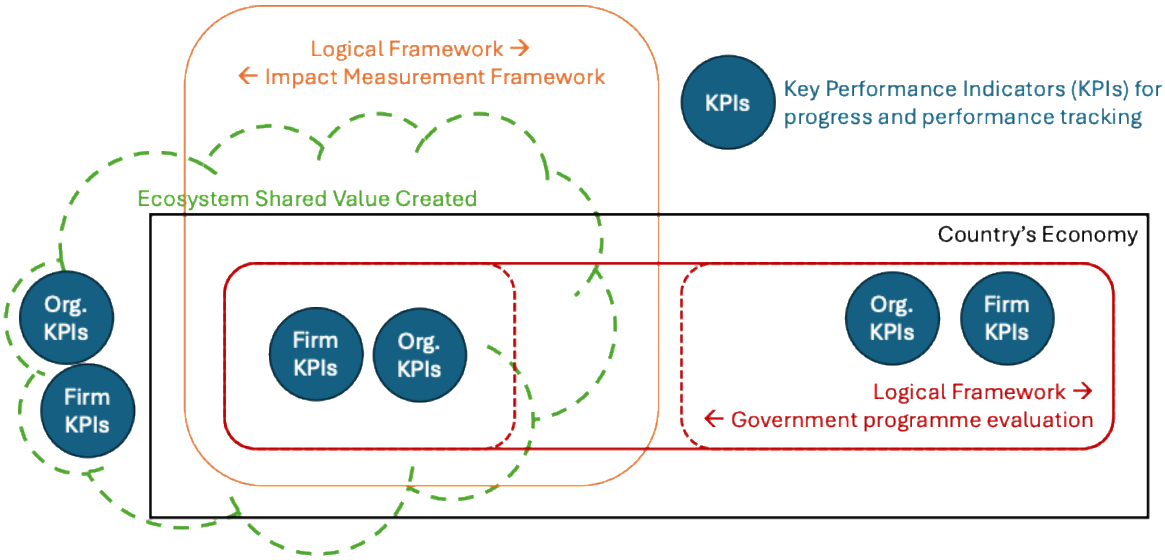
Dieudonnee Cobben et al.,[104] for instance, state that indicators have yet to be developed to measure ecosystem internal performance and achievement of its objectives, or to compare the performance of different ecosystems. Like the 4POINT0 researchers, these authors suggest the use of machine learning (ML) techniques to gather and analyse the vast quantities of data needed to evaluate ecosystem performance. While this chapter does not provide a solution to the innovation ecosystem indicator question, it does offer food for thought and avenues to explore to develop good performance indicators.

This last chapter explores the different measurement frameworks relevant to planning, tracking and evaluating the impact of innovation ecosystems. Next, the chapter will delve into details about some of the qualitative, quantitative and new NLP-based methods used to build indicators, and other KPIs to assess impact. The chapter will conclude with several recommendations.

Different measurement frameworks

Innovation ecosystems create value that is shared among their actors and stakeholders, i.e. they contribute to generating more than the sum of all private value added together. This value, whether individual or shared, needs to be measured. Figure 5-2 schematises the coverage of different measurement frameworks used for this purpose. Progress and performance tracking (using various KPIs) are the most targeted and specific measurement frameworks for firms and other organisations. Government programme evaluation aims to measure the impact of programmes on the performance of these organisations, both within particular innovation ecosystems and outside of their influence. The same programmes often target a wide range of firms. Parts of these innovation ecosystems are located within specific regions (e.g.. Quebec's Innovation Zones), provinces or countries, but innovation ecosystems encompass organisations outside of the remit of any given country or territory. Impact measurement frameworks operating within regional or national bounds are therefore likely to miss some of the story.

Figure 5-2 – Various interacting measurement frameworks



While these measurement and evaluation frameworks operate at different levels and have distinct objectives, all develop indicators and KPIs to assess performance and the path towards performance and broader impact. Hence, both public and private organisations build indicators and KPIs for the specific purpose of fuelling decision-making mechanisms and various impact measurement frameworks. At the ecosystem level, measuring the shared value created must therefore draw its inspiration from a multitude of measurement frameworks to gain a full understanding of this value.

Logical framework

A logical framework is often used in the initial design of a project, government programme or ecosystem to ensure clear objectives, the steps to achieve them, and logical connections between activities, expected results, outcomes and impacts. It is primarily used for internal monitoring, to inform decision-making, and to optimise innovation activities, in order to

ensure that an organisation meets its impact goals. A logical framework is a planning, monitoring and management tool (generally prospective) used to design and implement projects.[bb] It outlines the logical relationships between inputs, activities, outputs, outcomes, and impacts.[cc] These metrics focus on monitoring specific business goals and enhancing operational efficiency within a company, ecosystem, or policy context. They typically concentrate on immediate (outputs) or intermediate results (outcomes), accomplishments, and performance (impact), enabling organisations to evaluate the progress of their innovation initiatives.

> 'GICs evaluation is problematic because, despite their geographic anchoring, they focus on the development and application of technologies in broad areas at the national level. These are not geographically confined, but cut across many different industries, and therefore require national, continental, or global partnerships: metrics developed at the regional scale or confined to a sub-set of formally participating organizations, may simply be inappropriate. Furthermore, capturing the whole impact of innovation policy is not possible with quantitative variables; qualitative systems are needed to monitor the evolution sectors and collaborative processes.'
> — Iryna Fil Kristensen, Richard Shearmur, & David Doloreux (p. 296)[37]

A logical framework is generally structured along the following five dimensions (see Figure 5-3):

- **Inputs** – Financial, human, and material resources needed to carry out a project, or at the disposal of the ecosystem (e.g. funding, staff, equipment).
- **Activities** – Actions taken within ecosystems using these inputs to implement a project, specific tasks performed to achieve outputs (e.g. training sessions, number of workshops held, research, policy changes).
- **Outputs** – Immediate or short-term deliverables, direct and measurable results of an activity (e.g. number of research papers published, prototypes developed, reports published).
- **Outcomes** – Short- to medium-term changes, or effects of the outputs (e.g. skills gained, improved research capabilities, policy adoption, enhanced adoption of a new technology).
- **Impacts** – Long-term effects, broader changes that result from the outcomes, ultimate goals and value created in society, the economy, or the environment (e.g. higher

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[bb] See for instance the framework proposed by the Netherlands for their research and innovation ecosystems (see Figure 2, p. 6):
Government of the Netherlands, Strategy to Strengthen Research and Innovation Ecosystems, Ministry of Economic Affairs and Climate Policy. 2021. [Archived copy]
https://www.4point0.ca/files/sites/99/2025/12/Netherlands-2021-DutchStrategytoStrengthenResearchandInnovationEcosystems.pdf

[cc] See Appendix II of the INNAXE Guidelines for ecosystem monitoring, benchmarking, and impact evaluation results:
BioRN, Guidelines for ecosystem monitoring, benchmarking, and impact evaluation results. 2022, Danish Life Science Cluster, Inclusive & aligned INNovation Agendas across Europe.
https://www.danishlifesciencecluster.dk/en/project/innaxe-inclusive-alligned-innovation-agendas-across-europe/

employment rates due to training programs, increased competitiveness of an industry, economic growth, improved well-being).

Depending on the context and the innovation ecosystem, different categories of indicators can be defined, as can the relationships between them. In the example in Figure 5-3, the categories A, B, and C are connected by arrows mapping their relationships across different columns. Figure 5-4 highlights relationships in a hypothetical innovation ecosystem with five indicator categories: skills, actors, networks, knowledge & technologies, and value. Here, the logic of the relationships between various indicators is apparent (e.g. the number of training sessions – activity – may lead to a higher number of people trained – output). Each dimension can be composed of one to several indicators.

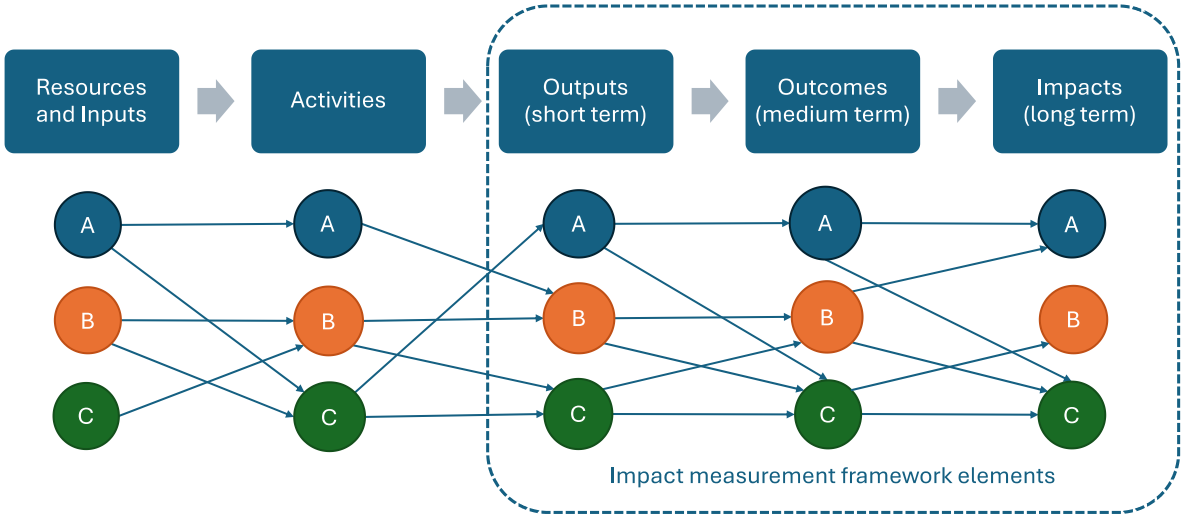

Figure 5-3 – Dimensions of a logical framework

	Resources & inputs	Activities	Outputs Short term	Outcomes Medium term	Impacts Long term
Skills	% data scientists	# AI training programmes	↑ % data scientists	↑ # data scientists employed in or outside IE	↑ AI-skills applied to solve society's challenges
Actors (who & for whom?)	% AI-aware firms	# SMEs involved in AI projects	↑ % AI R&D activities by SMEs	↑ sales of SMEs involved in projects	↑ digital transformation of society
Network (how)	AI-research centers links w/ industry	# AI collaborative projects	# & strength of new relationships	↑ # SMEs involved in a local supply chain	↑ sustainability of relationships
Knowledge & technologies (K&T) (what)	# prior AI-IP in IE	# hackathons to recombine K&T	# new technologies developed	↑ # IP licences granted	↑ Revenues from IP licences
Value (why)	Individual value	% projects with socio-environmental impact in mind	Development of AI adoption in SMEs	↑ % local resources transformed in Canada	↑ IE SV, ↑ in well-being, ↓ in GHG

Figure 5-4 – Hypothetical example of logical framework for an innovation ecosystem, showing relationships between indicators

Impact measurement framework

An impact measurement framework is generally applied later, to measure the wider impact of innovation initiatives and unintended consequences of projects, government programmes, ecosystem activities, or realisation of a mission. It is a performance assessment tool (generally retrospective) used to evaluate the effects of an initiative by systematically tracking and analysing its impact over time. Going beyond evaluating immediate results and outcomes, it adopts a comprehensive and systemic approach to examining spillover effects and assessing the long-term impact on society, the environment, and organisational development. In essence, impact measurement frameworks are closely akin to determining ecosystem shared value.

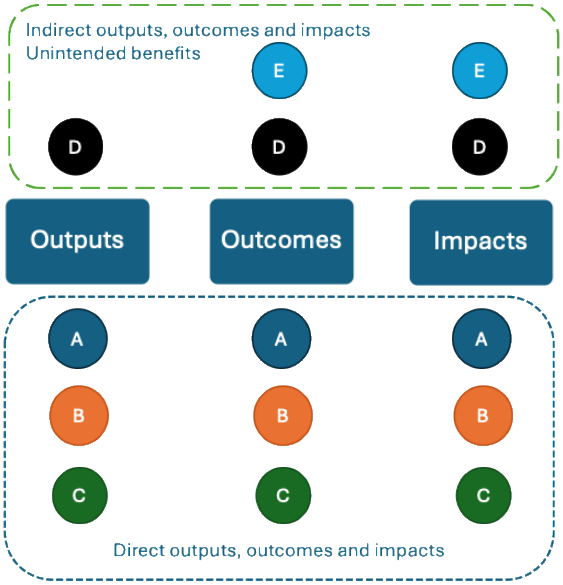

Figure 5-5 – Dimensions and categories of indicators in an impact measurement framework

Figure 5-5 presents typical elements of an impact measurement framework. Both direct impacts and unintended benefits are measured after the completion of a project or a programme. In comparison, a mid-term evaluation would not be able to measure the broad direct and indirect impacts of a project or a programme. It would be limited to outputs and outcomes.

These frameworks combine quantitative and qualitative assessments, including indicators like ecosystem development indicators, knowledge spillover metrics, capability maturity evaluations, job creation, economic value creation, improved quality of life, social return on investment measures, community well-being indicators, environmental impact metrics, and social and ecological resilience. The method developed by the *Bureau d'Économie Théorique et Appliquée* (BETA – see the section below) is a typical example of an exhaustive impact measurement framework.

Government programme evaluation

The aim of government support programme evaluation is to assess public policy implementation and the effectiveness of government programmes designed to foster innovation. It requires both a logical framework (planning and monitoring), and an impact measurement framework (retrospective). Multiple perspectives are generally considered, such as economic growth, competitiveness, and even social and environmental benefits. It usually includes both process evaluations (how the programme was implemented, the efficiency of resource usage) and outcome evaluations (what it achieved, whether it reached its intended beneficiaries equitably), and often assesses its sustainability (whether the benefits continue after programme completion). It considers not only quantitative results, such as the number of SMEs and startups funded or the amount of private investment leveraged, but also qualitative insights, such as whether the programme reduces barriers to

innovation or enhances collaboration between academia and industry. These evaluations help policymakers refine their strategies, ensuring that public investments generate sustainable and impactful innovation outcomes. In innovation contexts, government programme evaluations often need to justify risk-taking with public funds while acknowledging that many innovation investments will fail but might still create valuable knowledge. At present, too much of what we call evaluation is partial at best, as explained by Peter Philips in Box **5-1**:

Box 5-1 – Current state of programme evaluation

Most programme and ecosystem evaluations are only evaluated well after the efforts were initiated. Only then do they construct logical models and evaluation approaches, which means most evaluators have to use constructed or proxy data rather than data collected in real time that directly addresses actions and behaviours. This leads to survivor bias in the results. Ideally every programme, policy or service should set up an evaluation rubric before starting, including a clear logic that shows causal links between inputs, activities, outputs and outcomes/impacts, and clear and measurable metrics that can be measured in real time during delivery.

Much evaluation provides what my University of Victoria colleague David Castle calls 'just so stories', where we only examine the developments we work with, and even then, often narrow our assessment to the subset of winners from our efforts. We need more counterfactuals (i.e. companies that never engaged with any ecosystem, including those that self-selected or were rejected for policy and programme support, or that failed before term), and then we need to monitor and report on differential impact and not just absolute change.

Many evaluations are too narrowly cast, so that any measurable impact is not necessarily properly assigned. We tend to totally ignore spill-ins and spill-outs, and generally do a poor job of examining the full array of investments by all participants, instead focusing on the specific public inputs under review. Most ventures have a host of confounding and supporting variables of merit. Concentrating on a few things often leads to misattribution of the impact, as value is misassigned in the absence of important variables.

Much of our evaluation is self-serving and overly purposeful, in that we are absolutely looking for success stories. The best evaluation always has some kind of refutable hypothesis. Finally, most evaluations are conducted once and then shelved, so that we never see the cumulative/dynamic effects and are unable to build up data to construct meta-analyses. We need to direct research towards retesting data to see if we can find better explanations.

— Peter Phillips

Peter Phillips' call to action leads directly to Recommendations 5.1 to 5.4 in the conclusion of the white paper. It is imperative that Canada develop its capacity to measure and draw strategic intelligence from the data collected.

***

All of these planning, tracking and measurement frameworks are necessary for the establishment and impact assessment of innovation ecosystems. Planning and monitoring for shared value creation within innovation ecosystems requires the establishment of a clear logical framework, and measuring the shared value created needs an impact measurement framework. Furthermore, as some innovation ecosystems are the result of deliberate policies, the support programmes behind these initiatives require a separate evaluation framework. Government programme evaluations assess the effectiveness, efficiency, and relevance of government support programmes. Their goal is to determine if a programme achieved its intended policy goals and whether improvements are needed. Such programmes often need to balance public interest, taxpayer accountability, and complex societal needs.

Innovation indicators

Each of the measurement frameworks mentioned above relies on KPIs and other indicators that come from a wide variety of sources to cover several economic, social, and environmental dimensions. This chapter will focus specifically on innovation related indicators and KPIs.

Innovation performance indicators are important for assessing the effectiveness and impact of innovative activities within organisations, industries, or entire economies. These indicators capture diverse facets of innovation, from generating new knowledge to developing and bringing new products and processes to market. The OECD's *Oslo Manual 2018* [102] defines an innovation indicator as a statistical summary measure of innovation activity, output, or expenditure.

An innovation indicator must fulfil certain criteria to be effective in providing meaningful insights: it should be **relevant**, **accurate**, **reliable**, **current**, and **consistent or comparable**. By extension, the data used to construct these metrics must meet the same standards.

> 'An innovation indicator is a statistical summary measure of an innovation phenomenon (activity, output, expenditure, etc.) observed in a population or a sample thereof for a specified time or place. Indicators are usually corrected (or standardised) to permit comparisons across units that differ in size or other characteristics.'
> — OECD, Oslo Manual 2018 (p. 214)[102]

More precisely, for a given indicator to be considered **relevant,** it must align with users' needs, informing their analyses and decision-making processes. To be considered **accurate**, an indicator must precisely measure the phenomenon it is intended to capture. It is **reliable** if it is consistent, such that repeated measurements generate the same results. An indicator is considered **current** if it is up-to-date enough to facilitate timely decision-making. It is considered **consistent or comparable** if it has demonstrated a certain degree of universality that allows for valid comparisons across time, diverse groups, and different levels (e.g. organisation, region, sector, ecosystem, or country).

The same rigorous criteria must apply at the ecosystem level.

Example indicators for a logical framework

Without being exhaustive, there are as many indicators as there are logical frameworks and impact measurement frameworks (see the two frameworks mentioned in footnotes [bb, cc]). To illustrate how measurement frameworks and their indicators are co-constructed, Figure 5-4 presents a hypothetical[dd] logical framework around five categories of indicators: skills, actors, networks, knowledge and technology, and finally value. To simplify, only one indicator per category is presented for a typical innovation ecosystem aiming to foster sustainable digital transformation. As mentioned above, each category generally comprises several indicators for each of the dimensions. The goal of this section is not to comment on each indicator, but to draw attention to the challenges related to data collection, metrics construction, their geographical or network reach, etc.

> 'Homogeneity of what is asked for companies is key to easy access. This way you will have data homogenisation and it would be much easier for researchers and on government level to use that data. Right now, you need to go through different ministry levels and ask to get access to specific data about companies or programs and every time it is different.'
> — Loïck-Alexandre Gautier, cited by Nicolas Sacchetti [96]

The development of **skills** ('how') and assessment of their impact is a particularly tricky category to measure and link directly to outputs, outcomes and impacts. Accurately collecting data in this regard requires detailed questionnaires sent to individuals and their immediate superiors. Otherwise, it is almost impossible to measure changes in skills as a consequence of training activities organised within an ecosystem. We often have to fall back on 'low-hanging fruit' indicators that measure the training provided, the number of people who have taken part, and so on. If, some time after the training was rolled out, the level or value of the innovation impact increases, it may be possible to associate the training with this increase. However, a causal link would be very difficult to establish. It is therefore understandable that there are no standardised measures for assessing the impact of various training programs on improving the skills that underpin an innovative economy – the exception perhaps being at the macro level (e.g. province or country). Such indicators therefore require careful consideration in the development of a measurement framework, in order to co-design, test and validate new innovative skills indicators. As Gagné et al. highlight, skills indicators are important, but generally difficult to quantify:

> 'No single measure will fully and accurately demonstrate how an [open innovation – OI] event impacts its innovation ecosystem. Each event will have multiple measures, and the most appropriate ones will be determined by one's needs, ability to gather information, and the audience one wishes to persuade. Nonetheless, there is agreement on the importance of certain measures, including […] centralised (nongeographic) interactions, learning new problem-solving methods, and improving the innovation mindset.
> The respondents thought the other measures were less important because they were difficult to apply or quantify.'
> — Coralie Gagné, Sophie Veilleux, Fabiano Armellini, Patrick Cohendet, & Luc Sirois (p. 36)[76]

[dd] Most of our work with partners in this regard is confidential and cannot be presented in detail.

How the **actors** contribute to ('who') and benefit from ('for whom') the ecosystem requires that they directly assess their performance in relation to their activities within the ecosystem. In the example presented in Figure 5-4, the percentage of AI-aware firms in the ecosystem is expected to increase as a consequence of activities organised by the orchestrator, and this will ultimately lead to increased digital transformation of the ecosystem and society in general. By the same token, SME involvement in AI-related projects and R&D is expected to lead to increased sales from the innovations generated. Research and innovation intermediaries will provide advice regarding which government innovation support programmes (e.g. grants, tax credits) SMEs may use for this purpose. A combination of factors influences the firms' expected increased performance. Disentangling impacts and attributing them to different government programmes and orchestrator actions is no easy matter.[ee]

The links and connections of the **networks** ('how') created can be counted and the resulting network characterised relatively easily. The importance and impact of the relationships, however, are difficult to measure adequately. A more comprehensive qualitative evaluation and a detailed survey qualifying contractual and collaborative links, the importance and use of information sources, etc., is necessary for this purpose. Simpler data and indicators that are relatively easy to obtain will likely tell only one part of the story, i.e. who collaborated with whom, and with how much funding or other quantifiable support.

> 'An innovation ecosystem can be viewed as the sum of connections of businesses, typically in a region or industry, including key actors in supporting sectors such as academia and government, that influence innovative performance.'
> — Jan Youtie, Robert Ward, Philip Shapira, Sandra Schillo, & Louise Earl (p. 255)[14]

In contrast, a much easier measurement path exists for the creation and utilisation of **knowledge and technologies** ('what') within the innovation ecosystem (i.e. the traditional innovation linear model is pertinent here[ff]). While scientometric and technometric analyses have well developed methods to track the evolution of science and technology (mainly through scientific articles and patents), the adoption of these technologies, the revenues generated, and the broader economic and socio-environmental impacts are much more elusive to assess. We address this below in the description of qualitative approaches (i.e. BETA methods and the creation of new indicators for open innovation events) to complement these more quantitative methods.

Finally, the **shared value** ('why') generated within each innovation ecosystem depends on its general objectives, which should include both socio-environmental and economic considerations. Shared value is an ecosystem's *raison d'être*. Ecosystems have resources and inputs at their disposal that are generally reflected in the *individual value* for actors and stakeholders. At the other end of the impact measurement framework is the *shared value* – and this is expected to be more than the sum of each member's individual value. The

[ee] This requires careful econometric modelling rather than traditional impact measurement framework indicators.
[ff] Annex B provides a brief overview of some of the most commonly used indicators.

measurement process must also be adapted over time to reflect the fact that the value of a technology tends to increase as it advances (or sometimes fades as it is replaced), the innovation ecosystem coevolves with its individual actors, collaborations and networks reconfigure, and so on.

> 'In order to achieve environmental performance targets, it is essential to bring together experts from different fields to collaborate in an integrated design practice.'
> — Sara Rankohi, Professor, UQAM (21 November 2023) *Trajectoires d'innovation dans l'industrie de la construction* [Webinar] www.4point0.ca/s/5586

To illustrate, Table 5-1 presents hypothetical examples of indicators, using the same indicator categories as the previous example (see Figure 5-4). The table offers more indicators per category, while the figure focuses on only a few indicators, emphasising their potential interrelations.

Some indicators may fall short in capturing the unpredictable nature of innovation, or unintended impacts (e.g. simply counting patents as a measure of innovation instead of evaluating both direct and indirect effect of innovation activities). These are often relatively 'low-hanging fruits' or 'bean-counting' measures, as they may act as disincentives to collaborate, and threaten ecosystem cohesion. Too narrowly defined indicators risk incentivising incremental improvements over transformative innovations (e.g. counting the number of projects may encourage organisations to multiply the number of very short projects).[gg]

Catherine Beaudry and Laurence Solar-Pelletier [105] provide a critical commentary of the list of indicators demanded by the Innovation Superclusters, identifying some of the biases they may induce. For instance, counting the number of projects needs to be balanced by considering the size of the projects. Careful attention is required towards both numerators and denominators of ratios used as indicators. While indicative, they must absolutely be complemented by more detailed data and qualitative indicators to characterise these numbers. In addition to the number and percentage of partner organisations collaborating on projects, including a breakdown by type of organisation (e.g. SME, large company, government laboratory, academic institution, college technology transfer centre[hh]) would be more informative indicators. The pros and cons of each indicator need to be rigorously assessed.

> 'The indicators we impose on innovation zones, superclusters and different organisations must not be part of what I call a zero-sum game. If you count people going to events, [as] SME owners have a finite amount of time, they can't attend every event.'
> — Catherine Beaudry (29 January 2020) *Launch of Quebec's Innovation Zones Programme*

[gg] Examples include idea submission rates, R&D expenditure, the number of patents filed, the number of new products launched, the time-to-market for new products, or the percentage of revenue generated from recently developed solutions (often not more than 3-5 years old).
[hh] *Centre collégial de transfert technologique* – CCTT.

Table 5-1 – Hypothetical example of categories and their indicators within a logical framework

Categories	Dimensions				
	Resources & Inputs	**Activities**	**Outputs Short Term**	**Outcomes Medium Term**	**Impacts Long Term**
Skills ('how')	•% individuals with specific skillsets •# researchers in relevant disciplines •# R&D employees in member firms	• # training activities organised • # enrolled in training activities • % investment in training	• # trained individuals • Talent attractiveness from national and international labour pools	• # trained individuals that have found positions in or outside IE	• Contribution to the ecosystem / society by the trained or attracted individuals
Actors ('who' & 'for whom')	Presence of: •colleges and universities with pertinent disciplines •Incubators / accelerators •Innovation intermediaries •SMEs •Larger firms	• # SMEs involved in projects • $ funding for projects and universities	• # new active members • # new R&D activities undertaken in SMEs (size and importance) • $ investment attracted as a consequence of projects	• # employee of SMEs involved in projects • Sales growth of SMEs involved in projects	• Contribution to socioenvironmental shift in the Canadian economy • Will of actors to contribute to IE success
Networks ('how')	•Strong collaborative culture •Presence of an innovation intermediary for networking	• # collaborative projects • # networking activities • # new stakeholders involved in activities	• # partners, collaborators • # new relationships established • Strength of relationships	• $ invested as consequence of the projects • Development of a local supply chain	• # SMEs with rapid growth as a consequence of projects • Sustainability of relationships
Knowledge & Technologies ('what')	•Relevant science & technology availability locally, in province or in country •Prior IP in IE firms	• Collective research within IE • # projects undertaken	• # of patents filed/granted • # technologies developed • Knowledge sharing within IE	• # IP licences granted • # technologies adopted • # university technologies reaching the market	• Revenues from these IP licences • Economic and socio-environmental impact of these technologies
Value ('why')	•Individual value of IE actors and stakeholders	• % projects with socio-environmental impact in mind	• Development of a Canadian market • Increase in local employment level	• $ local revenues • # local employees • $ tax revenue generated • % local resources transformed in Canada	• Increased IE SV • Decrease in GHG • Increase in well-being

The BETA impact measurement framework

While there is substantial literature on qualitative methods for measuring impact, most focuses on storytelling or providing a narrative to explain or nuance quantitative measures. The paragraphs below present a summary of the method developed by Cohendet and his colleagues at the *Bureau d'Économie Théorique et Appliquée* (BETA) of the University of Strasbourg. Their approach aims to provide a more detailed and nuanced understanding of an organisation's impact by combining conventional metrics with customised qualitative indicators. The BETA method uses in-depth interviews with a representative sample of participants in a large research project. Interviewees quantify the impact of technological, commercial, and organisational factors on sales, mainly affecting costs. Each benefit or cost is associated with a change in value added. The organisation's financial contribution to overall development costs (e.g. the proportion of support) is considered when determining the percentage of increased value that can be attributed to their actions.

The BETA method is designed to evaluate the impact of a large research programme, typically one managed by a single organisation. It was originally developed in the late 1980s to evaluate the European Space Agency's (ESA) European space projects. The method has since been used to evaluate the impact of various research programmes, including the Brite-Euram programme on new materials, the Esprit projects, the Canadian Space Agency's space projects, and the TransMedTech Institute's research programme (see Box **5-2**).

A large research programme has specific goals, such as satellite development or material innovation. However, due to financial incentives for collaborating parties, the unintended knowledge spillovers (or 'indirect effects') arising from joint efforts can significantly enhance the programme's overall impact. These include new knowledge, technology, skills, quality, processes, and markets, that participants gain from research programmes and can use elsewhere. It extends beyond contractors and affects the entire economy. Indirect effects can also be measured in terms of changes in value added.

Skills development and the workforce involved in the organisation's activities, as well as those of its partners and beneficiaries, are key considerations. Interviewees provide data on the number of employees maintained or hired due to the programme's funding, the development of new competences within the firm and collaboration agreements in monetary terms (salary dollars). Additional data are collected on technology, applications, and timing to provide a more comprehensive analysis of indirect effects.

The selected indicators fall into two main categories:

- **Classical indicators**: These are the traditional measures used to assess research and innovation, such as the number of publications, patents, prototypes, new products or services, commercial contracts, and the creation of start-ups. They help evaluate the direct and quantifiable outcomes of a linear innovation process.
- **Complementary impact indicators**: These indicators aim to better reflect the organisation's role as a catalyst for scientific collaboration, open innovation, and co-construction with stakeholders. They are identified through in-depth analysis of the organisation's activities, such as support for technology platforms, project assistance,

and training. These indicators include learning new methods, improving skills, reducing costs and timelines, and enhancing reputation and trust.

Other indicators quantify the financial influence of the organisation on other ecosystem actors and stakeholders, while accounting for the complexities and uncertainties of indirect effects. Key elements of the method include:

- **Value-added estimation:** The analysis focuses on the additional value created for beneficiaries by the organisation's support, or the potential loss they would have incurred without participating in its initiatives. The main dimensions considered are technological, commercial, organisational and skills related.
- **Conservative estimation:** Since some benefits (e.g. scientific publications) are difficult to attribute solely to the organisation, the methodology focuses on a minimal estimate of all effects. This approach ensures a cautious yet reliable assessment by using only the lower bound of the estimated impact range provided by corporate managers.
- **Aggregation of individual data:** Measuring impact in terms of added value allows the method to aggregate individual case data and provide an overall estimate of value creation across different activities.
- **Impact multiplier:** The study estimates the impact of each dollar invested in the organisation's activities. It is a conservative estimate, as it assumes the lowest possible effect when interviewees are uncertain.

Due to time constraints, the evaluation remains deliberately conservative. A longer-term study would likely reveal a significantly higher overall impact multiplier, in particular by taking into account the direct impact of implemented technologies or the broader indirect effects on the ecosystem.

Such an exhaustive data collection method is incredibly time consuming. For a government that requires an overview of the impact of its STI policies, deploying such a method is inconceivable. This is why 4POINT0 members ventured into new data and new analytical methods, to be presented in the next section.

Box 5-2 – Impact measurement framework for TransMedTech Institute (iTMT)

The evaluation framework developed by the team at HÉC-Mosaic to assess the impact of the activities of the TransMedTech Institute (iTMT), a 4POINT0 partner specialised in innovation, co-creation, and acceleration of next-generation medical technologies, combines both traditional impact indicators and those specific to open innovation and the broader healthcare ecosystem. This approach ensures a more comprehensive assessment of the institute's contributions to research and innovation in health technology, as well as to capacity building, training of highly qualified personnel, knowledge mobilisation, and the development of inclusive, patient-centred solutions. The method is based on a series of detailed interviews and follows the BETA methodology described above.

Measurement framework and types of indicators

Traditional indicators (linear innovation model) – These conventional indicators measure the direct outputs of research support, reflecting a classic linear innovation process. They include:

- An increase in the number and quality of scientific publications (e.g. growth in h-index)
- Greater success in obtaining research grants
- An increase in the number and value of patents filed
- Growth in the number of commercial contracts secured
- The creation of new start-ups and spin-offs
- Expansion of a highly qualified workforce

Typically, indicators corresponding to the early stages of innovation (such as publications) are difficult to measure in terms of their prospective economic value, while those related to later stages (such as start-ups and commercial contracts) can often be quantified in monetary terms, representing an increase in added value. The former are also considered outputs of the knowledge ecosystems mentioned in the introduction, while new start-ups and spinoffs are important outcomes of the entrepreneurial ecosystems as well.

Indicators related to open innovation – Given that iTMT fosters interdisciplinary and intersectoral collaborative research through open innovation and creative processes, additional impact indicators have been identified. These reflect the unique value created by iTMT's support:

- Reputation, legitimacy, and trust building: The open lab model increases visibility, leads to valuable networking opportunities, and facilitates access to new academic, industrial, and patient partners. This can lead to new funding, awards, contracts, or even unexpected partnerships.
- Better understanding of patient needs and market demand: Direct interaction with patients allows for real-time feedback, improving research solutions and accelerating project development.
- Knowledge transfer and learning: Beneficiaries learn about different methods, such as business models, ISO standards, and intellectual property rights. This saves time and money, reducing the need for external consultants.
- Skills development and workforce retention: The shared resources available in open lab environments, and the recruitment of highly qualified personnel (HQP) through iTMT's technological platforms, help maintain and enhance expertise within the research ecosystem.
- Attracting and training young talent: Open innovation models appeal particularly to young professionals and researchers, who are more likely to seek employment in organisations actively engaged in open lab initiatives.

Impact beyond direct beneficiaries – To fully capture iTMT's contributions, a broader perspective is needed, encompassing indirect and systemic effects:

- Impact on patient health: iTMT aims to facilitate the transfer and implementation of next-generation medical technologies. To assess their impact, a value-based assessment model is being developed to measure cost-effectiveness and socio-economic impact.

- Impact on the overall healthcare ecosystem: iTMT's activities generate indirect benefits, like fostering collaborations through an extended professional network, facilitating industrial funding, and contributing to a cultural shift towards open innovation practices in health research.

Summary of impact

Although this impact measurement framework focuses primarily on the direct beneficiaries of iTMT's support, preliminary interviews suggest significant direct and indirect impacts (see Figure 5-6). For instance, beneficiaries report reduced costs for accessing technological platforms and faster adoption of open innovation practices within the healthcare sector. Moving forward, a more in-depth evaluation using a statistically representative sample would provide a more precise measure of iTMT's long-term impact on healthcare innovation, by evaluating in particular the direct effects of the research programme of the final users (e.g. patients, caregivers).

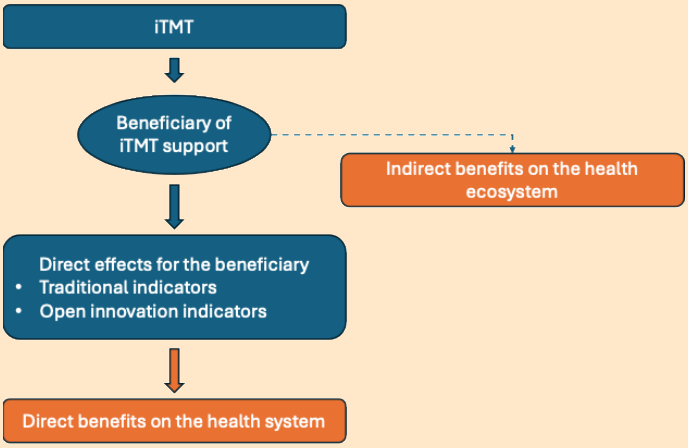

Figure 5-6 – Direct and indirect benefits of iTMT

In a recent complementary study (HÉC-Mosaic, 2022), 55 additional semi-structured interviews were conducted, which further confirmed the transformative role of iTMT across several dimensions. The interviews highlighted enhanced interdisciplinary collaboration, increased adoption of Living Lab practices, accelerated project timelines, improved funding success rates, and stronger integration of patient-centred approaches. Respondents also emphasised gains in legitimacy, reputation, and network expansion, as well as the critical role played by iTMT in facilitating innovation transfer and building a shared culture of open innovation in the health ecosystem. Moreover, the study helped characterise and quantify direct impacts such as reduced development and grant acquisition timelines, and indirect impacts such as improved knowledge transfer, broader stakeholder engagement, and increased social capital. A conservative estimate suggests that every dollar invested by iTMT generates a minimum of three dollars in economic value for supported projects, highlighting its catalytic effect within the health innovation ecosystem.

— Patrick Cohendet

New innovation indicators

The development and application of innovation indicators have gained critical importance in recent years, as scholars and policymakers strive to measure and understand the diverse impacts of innovation on economies and society.

Most of the research undertaken within the 4POINT0 community did not focus on building new logical frameworks, nor new impact measurement frameworks. Instead, it explored how to collect new types of data, design new indicators for specific activities, and validate these new indicators with classically collected and built indicators.

Four projects in particular focused on the development of new innovation performance indicators, with a common goal of advancing beyond traditional metrics. These studies emphasise the limitations of traditional innovation metrics like R&D expenditure and patent counts, advocating for more nuanced indicators that capture complex aspects of modern innovation.

Cruciata et al.[103] argue that traditional metrics fail to account for the multidimensional nature of knowledge creation and the broader societal impact of innovation. They propose that science and technology indicators must evolve to include factors beyond economic returns, incorporating social and environmental effects to better reflect the innovation process in complex systems. In essence, they contribute to a novel way of assessing impact. Similarly, Mikaël Héroux-Vaillancourt,[106] Coralie Gagné,[76] and Thisse et al.[77] question traditional measures as inappropriate for capturing dynamic and emergent forms of innovation, such as those resulting from open and collaborative environments.

Innovative qualitative indicators

Gagné et al.[76] focused on one family of activities aimed at fostering an open innovation culture within innovation ecosystems. She analysed open innovation events as critical components within broader innovation ecosystems. The extensive qualitative study explored the perceptions of participants of hackathons and other open innovation events regarding their success. The authors identified 54 effective strategies, 34 markers of success for different participant groups and 11 short- and long-term impacts.[ii]

Their study found several signs of event success, such as new contacts, new talents, acquired resources, established partnerships, and new partners. They also identified outcomes, like innovative products or services, ideas generated, and problems solved. Impacts included new product/service success, improved customer and financial performance, increased market value, and boosted sales and production. They also emphasised new ecosystem effects, including centralisation of interactions, value of networks and adaptive spaces, learning, and enhancement of innovation mindsets and practices. These fall under the category of outcomes and impacts in a classic logical framework.

[ii] We encourage readers who would like to know more about these to consult the article: https://doi.org/10.1142/S1363919623500172

The authors highlight the significance of ecosystem involvement and network effects in promoting innovation results. They examine collaborative success markers in Quebec's innovation scene, revealing that successful ecosystem gatherings not only foster innovation but also facilitate knowledge exchange and network development. Their indicators on event-based data and participant interactions can serve as proxies for ecosystem health. They emphasise the importance of collaboration and engagement in evaluating open innovation outcomes. This conceptual framework was used in a subsequent quantitative study.

Innovative quantitative indicators

Thisse et al.[77] build on Gagné's work to test the contribution of these open innovation events to direct outputs and outcomes resulting from these networking activities (see Figure 5-7). Their findings suggest that in person (rather than online) open innovation events lead to greater satisfaction and likelihood of pursuing projects afterwards. Event participants identified an increase in skills and a more positive perception of the innovation ecosystem as a consequence of their participation in such activities. This study provides valuable insight into the design and running of open innovation and other networking activities within innovation ecosystems. These must be carefully crafted to ensure maximum impact. The authors stress that both best practices and success indicators vary according to the type of actor involved in the ecosystem (see Box **5-3** for more details). A targeted approach to measuring impact is therefore important.

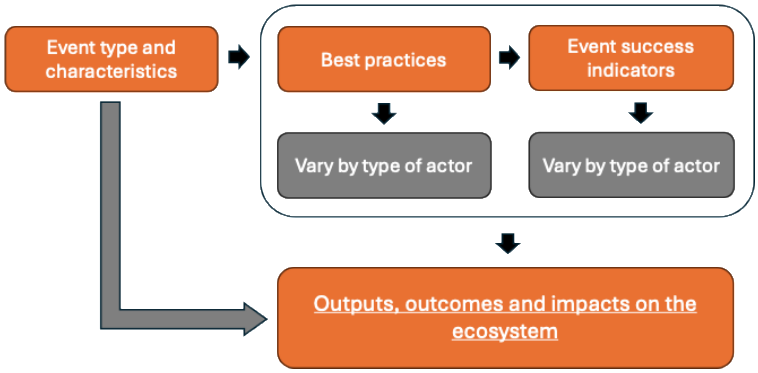

Figure 5-7 – Framework to measure impacts of open innovation events on innovation ecosystems

Box 5-3 – Impact of open innovation event design on event outcomes

Focusing on solvers (i.e. those that find solutions at hackathons and other open innovation events), Thisse et al.[77] build on the conceptual measurement framework developed by Gagné et al.[76] An important success indicator for solvers, highlighted by the latter study and corroborated by the former, was the long term benefits (visibility, credibility, potential collaboration) perceived by solvers and their likelihood to continue working on projects after the event. This long term commitment was facilitated by mentorship provided by ecosystem actors within the event. Such mentorship is key to 'learning' and 'knowledge transfer efficiency', two impact measures proposed by Gagné. This close relationship between mentors and solvers also increased the willingness of the solvers to repeat their participation in other similar events and contribute to building a long term commitment to the ecosystem. This only works, however, if the solvers are motivated to make a difference. Solvers that were already involved in the local start-up ecosystem, i.e. more akin to the entrepreneurial ecosystem, were more likely to continue their participation in the future, hence contributing to bridging innovation and the

entrepreneurial ecosystem. This makes them natural allies of the global orchestrators mentioned in Chapter 2.

In addition to increasing outputs and outcomes within the ecosystem, these types of events also increase solvers' innovation skills, their openness to interacting and developing relationships with the innovation ecosystem. In a sense, these are excellent means by which to recruit new members, attract talent, potentially create new ventures, and build a solid collaboration network within the innovation ecosystem. Gagné had indeed identified 'improvement in the innovation mindset and practice', 'value of networks and adaptative spaces', 'number of new partnerships', and 'number of businesses created' as important impact measures for innovation ecosystems.

— Catherine Beaudry, Fabiano Armellini, & Sophie Veilleux

Exploring new indicators with new methods

Both Cruciata et al.[103] and Héroux-Vaillancourt et al.[106] use corporate websites to build and then validate new web-based indicators of innovation. They argue that online activity and digital presence reflect dynamic interactions within the ecosystem and signal an organisation's innovation and related activities. While the latter explores traditional dimensions pertaining to innovation activities, the former addresses indicators related to the means to achieve environmental sustainability.

Héroux-Vaillancourt et al.[106] analyse firms' online content, identifying keywords associated with funding, R&D, collaboration, and intellectual property. Their web content–based indicators aim to bridge the gap between traditional survey-based data and real-time, easily accessible online data. To validate these indicators, they perform correlation and confirmatory factor analyses, suggesting that web-based indicators can serve as reliable proxies for firms' innovation activities, thus meeting the *Oslo Manual* standards of accuracy and relevance. The authors demonstrate that web-based metrics offer real-time insight into firms' innovation activities, particularly in sectors where digital presence is a proxy for innovation engagement. Expanding their method could help feed automated dashboards and lighten the data collection burden on both innovation ecosystem orchestrators and actors.

> 'Web-based indicators can act either as complements to direct measures or as substitutes for broader measures, notably the importance of R&D and the importance of IP protection, which are normally measured using conventional methods, such as government administrative data or questionnaire-based surveys.'
> — Mikaël Héroux-Vaillancourt, Catherine Beaudry, & Constant Rietsch (p. 1601)[106]

> 'Company websites are purposely structured in a cooperative and agreeable manner for anyone seeking information about products, services, activities, and so on. The self-reporting bias induced by this methodology is inevitable. However, it is important to note that questionnaire-based surveys and most national official public directories are all also subject to self-reporting biases. Fortunately, the bias induced by the web mining technique is as much a quality as it is a flaw, in that it

> provides insight on how a company wishes to be perceived. In fact, companies post what they care about, what is important to them, and who they are as an organization on their websites.'
> — Mikaël Héroux-Vaillancourt, Catherine Beaudry, & Constant Rietsch (p. 1628)[106]

While it does not address innovation ecosystems directly, the web-centric approach further developed by Cruciata et al.[103] advocates for a holistic view of innovation that includes environmental benefits. They use the natural language processing (NLP) model BERT (Bidirectional Encoder Representations from Transformers) to interpret the web pages of B-Corp certified companies in order to build a web-based indicator of environmental compliance. The authors then compare these new indicators with the real environmental index attributed by the B-Lab. Their regression analysis explains close to 60% of the variance of the real index, hence demonstrating the relevance of such quasi-real time web-based indicators. Their approach also aligns with the *Oslo Manual* criteria for innovation indicators, advocating for relevance, reliability, and comparability across time and different contexts.

> 'The results of the [zero-shot text classification] ZSTC score together with the companies' characteristics explain 57% of the variance of the B-Lab environmental index obtained by companies, thereby showing great promise for the proposed method.'
> — Pietro Cruciata, Davide Pulizzotto, & Catherine Beaudry (p. 2)[103]

The authors then propose an adaptive framework that incorporates indicators for social, technological, and environmental outcomes. Developing this more comprehensive framework could help address the broader socio-environmental impact and ecosystem shared value measurements highlighted above. At present, most research on the subject is based on case studies, rather than more extensive empirical analysis. As Piantoni et al. suggest, we have not yet mastered the art of measuring socioeconomic and environmental impacts with innovation ecosystems:

> '[Shared value] still lacks a robust measurement system, capable of capturing its economic, social and environmental dimensions through reliable data and indicators'.
> — Giulia Piantoni, Laura Dell'Agostino, Marika Arena, & Giovanni Azzone (p. 191)[72]

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Despite methodological differences, the aforementioned studies headed by Gagné et al.,[76] Thisse et al.,[77] and Héroux-Vaillancourt et al.[106] demonstrate that innovation indicators must reflect the collaborative nature of modern innovation processes, either through physical or digital networks. Where Cruciata et al.[103] emphasise creating adaptable frameworks that policymakers can apply across various regions and sectors, the studies by Héroux-Vaillancourt et al. (digital content), Gagné et al. and Thisse et al. (open innovation events) each focus on specific indicators tailored to unique contexts, suggesting a more specialised approach to indicator development. Each study's methodological framework highlights different dimensions of the innovation process, from digital interactions in Héroux-Vaillancourt et al. to the in-person dynamics emphasised by Gagné et al. and Thisse et al.,

yet all connect on the need for metrics that capture multi-faceted and interconnected elements of innovation. These studies underscore the need for innovation indicators that go beyond simple economic measures and ratios, to fully capture the complexity of knowledge flows and collaborative networks.

Conclusion

Developing a framework and the underlying indicators to plan for, track, and measure innovation ecosystem impact and shared value created is complex. This process requires several iterations, periods of co-creation between the ecosystem orchestrator, actors and stakeholders, as well as individually within each organisation. This iterative process is essential to refine the objectives, align the indicators with them, identify the necessary data and set up the collection processes. In a sense, the strategic planning of individual firms described in Chapter 3 needs to adapt and contribute to this iterative process to ensure mutually beneficial, or symbiotic, relationships within the innovation ecosystem.

Chapter 6
Conclusion and Recommendations

Catherine Beaudry
Fabiano Armellini
Mario Bourgault
Sophie Veilleux

In conclusion to this white paper, we propose several recommendations, as well as avenues for further research that will help address some of the questions they raise. Each of the previous chapters has presented the foundational phenomena that have led to the recommendations.

While Chapter 4 focused on policies and mechanisms to be put in place to foster innovation in general and to support the activities of innovation ecosystems in particular, the two preceding chapters presented two interrelated dimensions of how innovation ecosystems function: their orchestration (Chapter 2) and the individual practices of their members (Chapter 3). Chapter 5 suggests that, for proper functioning, businesses, ecosystems and governments alike must establish precise measurement frameworks and progress indicators to monitor the achievement of objectives and identify how to make adjustments.

With the exception of the first, the recommendations are therefore organised around the different types of actors and their respective fields of action.

Recommendation 1 – Learn what an innovation ecosystem actually is (and what it isn't)

An innovation ecosystem is not an industrial cluster, nor a collaboration network, nor a regional innovation system, nor a competitiveness hub. It is a little of all these things, without being any one of them. It is therefore essential to do your homework to gain a proper understanding of what an innovation ecosystem is exactly – and what it is not (reading Chapter 1 is a good start!).

For Innovation Ecosystem Orchestrators

Recommendations from Chapter 2 – Innovation ecosystem orchestration

In addition to the implicit recommendations of Chapter 2 regarding what the orchestration process entails, we propose, as a starting point, some general recommendations drawn from our research and observations.

Recommendation 2.1 – Develop an exhaustive and dynamic mapping of ecosystem members

A mapping exercise is not just a collection of logos – far from it! The orchestrator must be able to clearly understand the nature of the actors involved, their characteristics, needs, and short-, medium- and long-term objectives, as well as their existing relationships and the connections they build with members of knowledge and business ecosystems, and throughout their innovation, supply and value chains. Far from being static, this mapping should reflect the constant evolution of the ecosystem. Different types of actors are present, multiple hierarchical levels coexist, and links are continually being created and dissolved.

Recommendation 2.2 – Orchestrate the ecosystem you have

This recommendation could also be phrased 'write the recipe book with the local ingredients of your innovation ecosystem.' Too often, attempts are made to imitate or copy other regions, clusters, ecosystems or 'recipes' without having the right ingredients. The results are usually mixed. Solutions that succeed in one place are likely to fail elsewhere because of the specificities underlying local activities, intended goals, participating actors and their innovation, supply and value chains, and the relationships developed over time.

The type of orchestration must therefore be adapted to the ecosystem, its context and its objectives. A directive approach, in some cases, risks alienating members who are more accustomed to close collaboration. One can certainly draw inspiration from examples elsewhere without reproducing them wholesale. It is therefore essential to understand why a given form of orchestration works in a particular context, and to ensure that both the local actors and the context are conducive to its application before attempting to adopt it.

➤ Further research is needed on this topic.

Recommendation 2.3 – Constantly review and improve the orchestration of the ecosystem to ensure resilience

This applies to both the technologies developed within innovation ecosystems and to the member companies and organisations themselves. Collaborations also evolve over time as people are promoted or change roles (it should not be forgotten that it is humans collaborating with humans). Technological advances from elsewhere and scientific progress emerging from knowledge ecosystems continually reshape the environment for the actors within an innovation ecosystem. New enterprises are created, often as spin-offs from entrepreneurial ecosystems. These start-ups bring new knowledge that must be integrated into the ecosystem. In return, such small and newly established companies often require mentoring and additional support to integrate effectively into the ecosystem (see the first part of Chapter 4 on this point). The resilience and survival of the innovation ecosystem also depend on this contribution. Ultimately, orchestration should draw inspiration from the agile methods used in business.

Recommendation 2.4 – Ensure equitable access to knowledge and fair sharing of the value created

The advantage of innovation ecosystems lies in the fact that the value they generate exceeds the sum of the values that their members could create individually. The orchestrator must therefore ensure a sound balance between private value, which benefits the owners, and shared value, which benefits the wider community. As in any collaboration, working together does not mean having one's ideas stolen; many intellectual property protection tools exist to prevent this. However, careful thought must be given to the mechanisms for sharing knowledge, patents, technologies and value, so that no organisation is disadvantaged. We address this notion of shared value in Chapter 5 and propose some recommendations on this topic below.

Recommendation 2.5 – Take into account the characteristics, offerings, needs and demands of surrounding ecosystems

While for an individual company there is only one ecosystem – its own – innovation ecosystem orchestrators, such as innovation zones, are tasked with animating a community, coordinating activities, and attracting businesses, employees and funding. This orchestrating entity, or group of entities, must be aware of the knowledge being developed elsewhere (e.g. in local or external universities – knowledge ecosystems), of resources available in other regions or ecosystems (e.g. mining or manufacturing regions – complementary innovation or business ecosystems), and of potential markets to be developed outside the ecosystem (regional, national or international). Building bridges with organisations from these other ecosystems to co-innovate is desirable, but it also adds a level of complexity that remains to be studied.

➤ We are still in the early stages of developing the concept of 'global' orchestration. Further research is required on this subject.

For Organisations within Innovation Ecosystems

Recommendations from Chapter 3 – Practices and processes for leveraging innovation ecosystems

Recommendation 3.1 – Encourage the updating of strategic management frameworks to design innovation processes that are more aligned with ecosystem collaboration

It is clear that most technology and innovation management tools and frameworks date back to a period when the dominant model was closed innovation. Although these frameworks remain relevant and useful, they were not designed to help companies seize the leveraging opportunities offered by the ecosystems around them. It is therefore necessary to encourage, on one side, the creative efforts of researchers and innovation specialists to update these frameworks, and on the other side, their adoption by businesses.

Recommendation 3.2 – Equip ecosystems with tools for strategic ecosystem management

Just as companies and other organisations use a variety of strategic planning tools and technology roadmaps, we propose that innovation ecosystems should also equip themselves with such tools to support their dynamic process of 'global' orchestration. However, as with the previous recommendation, it is necessary to design frameworks and tools adapted to the ecosystem scale. Governance frameworks and relationships within an ecosystem, lacking the hierarchical structures that normally dictate the functioning of firms, require tools tailored to them in order to build a shared strategic vision and to design roadmaps that align with the individual roadmaps of ecosystem actors.

Recommendation 3.3 – Invest in programmes that promote and encourage the adoption of an entrepreneurial culture

As discussed in Chapter 3, strategic frameworks and innovative processes will have little or no effect without a cultural transformation within businesses, aimed at changing organisational practices around innovation, risk aversion, and fostering a growth mindset. To support innovation, it is necessary to strengthen an entrepreneurial culture. This recommendation operates on several levels: at the company level, it means encouraging intrapreneurial practices across all areas of business; at the university level, it involves transforming STEM education to develop transversal skills; at the government level, it translates into programmes and public policies that encourage and reward those who adopt an entrepreneurial culture focused on innovation and growth.

Recommendation 3.4 – Invest in collaboration practices that work, including the creation of dedicated roles to support their deployment

Collaboration within an ecosystem requires time and resources. It demands that participants be willing to commit and share a common vision of the value it provides. Since collaboration is critical for the effective deployment of innovation processes, it cannot be improvised; it must be supported and facilitated by actors who believe in it. New roles should be created (champions, facilitators, etc.) to ensure that collaboration is active, productive and sustainable.

Recommendation 3.5 – Identify and mobilise actors who are motivated and capable of driving adoption to completion

At the ecosystem level, the adoption of new practices and tools follows a trajectory that is often difficult to predict with precision. Although the processes and practices that support adoption are known, their deployment is subject to a variety of influences. Innovation promoters must learn to navigate these influences and maintain stakeholder commitment. In many observed cases, public or political actors have a considerable influence on supporting and ensuring the successful completion of adoption trajectories.

For Policymakers

Recommendations from Chapter 4 – Innovation policies

Recommendation 4.1 – Strengthen the links between innovation ecosystems and entrepreneurial ecosystems, and recognise the role of each

Policies related to entrepreneurship often seem to evolve in isolation from policies related to innovation and business growth. The transition from start-up to small enterprise, and then to a medium or even large company, is not taken into account by entrepreneurial ecosystems. In fact, innovation and growth often appear to be taken for granted. Yet the real impact of entrepreneurial ecosystems lies not in the number of start-ups they produce, but in the ability of these firms to create and capture value (and thus increase in value). Greater coordination is therefore required to ensure the mutual reinforcement of entrepreneurial ecosystems and innovation ecosystems. The demand for new services and technologies within innovation ecosystems should fuel the creation of start-ups nurtured within entrepreneurial ecosystems. This necessarily involves avoiding duplication of support programmes and initiatives. One suggestion would be to assign certain individuals employed by various research and innovation intermediaries to joint positions bridging these organisations and selected incubators and accelerators (a kind of 'cross-appointment'), in order to avoid redundancy and to facilitate the mobilisation of knowledge within the support network.

Recommendation 4.2 – Broaden the diversity of entrepreneurial training offered across the university network

As discussed in Chapter 4's section on entrepreneurial education, training needs vary depending on the audience: for some, the need is awareness of the entrepreneurial mindset; for others, it is the ability to identify and seize business opportunities; and for others still, it is acquiring the skills to launch high-potential start-ups, particularly in STEM fields. However, the Canadian entrepreneurial education system is currently heavily biased towards (and by) business schools. It is necessary to broaden the range of courses, not only in terms of audience (e.g. offering more courses to STEM students), but also in terms of the sources of such courses, so as to provide a broader and more multidisciplinary perspective on the art of entrepreneurship.

Recommendation 4.3 – Ensure a balance between the territorial anchoring of innovation ecosystems and their regional and national reach in innovation policy development

Innovation superclusters (a.k.a. global clusters) have been criticised for their disconnection from local roots. On the other hand, it is still too early to assess whether some innovation zones are too geographically anchored, to the detriment of provincial interests. Excellent examples of bottom-up approaches, particularly in healthcare, have produced promising results, and less top-down models of public policy that may serve as inspiration. The complementarity of innovation policies operating at different geographical levels, supporting different sectors or even different value chains, must be considered and rethought. In an

uncertain geopolitical context, accompanied by the need to realign pan-Canadian supply chains and to pursue 'friend-shoring' strategies, this exercise is more necessary than ever.

Recommendation 4.4 – Better align innovation policies with the needs of SMEs

SMEs find support application processes complex (see the following recommendation), but above all, the support itself is often too general and poorly aligned with their needs. In collaboration with innovation ecosystem orchestrators, innovation advisors, and research and innovation intermediaries – the actors on the ground – we suggest working jointly to simplify these processes, assess needs (see Recommendation 5.4), and deploy innovation policies that are aligned with both these needs and the capacities of the firms. Once trust has been established and support mechanisms have demonstrated their effectiveness, persuasion and encouragement can then fully play their role in helping SMEs go further and surpass themselves.

> When you go to a training centre for the first time, your physical condition is assessed. Then you are asked about your goals. You will not get the same training programme if you want to run an ultramarathon as if you simply want to climb the stairs without getting out of breath! — Catherine Beaudry

Recommendation 4.5 – Reduce the number and complexity of growth and innovation support applications as well as the data required

Reduce the number and complexity of growth and innovation support applications as well as the data required

Rather than multiplying the number of advisors and research and innovation intermediaries – who effectively replace employees who once handled this within companies, and whose role is to guide firms through the maze of measures for business innovation and growth support (BIGS) – we should simplify the process. Some progress has been made in Quebec's 2025–2026 budget, but much remains to be done, both federally and provincially.

➤ Back in June 2021, in a LinkedIn blog, we proposed a programme of 'precision BIGS'.[jj] It may be time to dust off this idea (we return to it indirectly in Recommendation 5.4).

For Policymakers, Orchestrators, and Research and Innovation Intermediaries

Recommendations from Chapter 5 – Innovation ecosystem performance

This chapter makes three recommendations for an adaptive, scalable and useful innovation ecosystem impact measurement framework and its associated indicators.

[jj] https://www.4point0.ca/en/2022/07/04/les-entreprises-propulsees-par-le-controle-de-leurs-donnees/

Recommendation 5.1 – Co-develop the policies, programmes, measurement frameworks and underlying indicators at the same time

This first recommendation proposes the co-development of logical and impact measurement frameworks concurrently with the measurable objectives and indicators that will assess their achievement. This is particularly relevant for emerging ecosystems, such as those showcased in Chapter 2. We propose that the objectives of an innovation policy (or innovation ecosystem) be clearly and collectively defined, encompassing both economic and socio-environmental impacts (the ecosystem's shared value). Then, further clarify and simplify the major objectives by adding sub-objectives, and at the same time co-develop output (short-term) indicators linked to each of the sub-objectives. This co-design stage would facilitate the fine tuning of the frameworks and of the indicators used to check that the short-term objectives are achieved. The same should be applied for the co-development of outcome (medium-term) and impact (long-term) performance indicators. If there is a need to slightly modify the objectives and sub-objectives or adjust some indicators as new information and new players come in, decision makers should not hesitate. This process should not be static, but dynamic and agile.

Recommendation 5.2 – Establish the connections between the various indicators

Inspired by classic logic models, at each stage of the co-development process mentioned above, the connections between the different objectives (and indicators) must be established to ensure that none are left without a prior objective (otherwise, it would be doubtfully achieved or with difficulty). For instance, some activities should lead to specific outputs, outcomes and impacts.

Recommendation 5.3 – Establish a world class data collection and indicator analysis system within an innovation observatory

The chapter identified a number of measurement challenges, particularly in relation to skills and networks. These will be exacerbated by notorious pitfalls associated with sharing data between organisations, regions, provinces, jurisdictions and so on. This is the Achilles heel of the Canadian data system. We have erected so many regulatory barriers in terms of data protection and ownership that it has become virtually impossible to combine data from different organisations.

Serious thought needs to be given to the types of data to be collected, how they are to be collected, the existing sources of this data, the organisations to be involved in the process, and how to reduce the data collection burden for the programme, the innovation ecosystems and the member organisations (actors and stakeholders). Implementing this recommendation requires broadening the pool of organisations involved in co-designing the measurement framework, at all stages of the co-development process proposed in Recommendation 5.1. It is illusory to propose indicators without having the data to measure them.

Finally, to return to the roles mentioned in the Introduction and Chapter 2, the orchestrator, as a source of collective learning, should be in charge of centralising and mobilising the knowledge needed for this co-development process collectively with the actors and

stakeholders of the innovation ecosystem. Innovation ecosystems should equip themselves with detailed dashboards for monitoring indicators, for their own management as well as the 'global' orchestration taking surrounding ecosystems into consideration.

Recommendation 5.4 – Create an intersectoral and interdisciplinary research institute for innovation

Following the OECD's lead, which recommends the development of strategic intelligence programmes, we propose the creation of a research institute whose mission would be to identify existing data, missing data, and data to be collected (see Recommendation 5.3 on creation of an innovation observatory) to feed into these programmes. In order to avoid directly copying the 'recipes' of other contexts, it is imperative that Quebec establish such a research institute to evaluate the impact of public policies supporting innovation and growth and the mechanisms deployed to do so. This institute should bring together researchers from academia, government, and various organisations that support business innovation and growth.

Annex A
Precursors to the Various Types of Ecosystems

Catherine Beaudry
Marie Gruber

Introduction

The term 'ecosystem' has gradually replaced other concepts such as districts, clusters, and national and regional innovation systems. This annex delves into the history, architecture, and influence of these terms/concepts, exploring how they affect innovation outcomes worldwide. While this annex briefly overviews the key concepts underpinning the widespread use of ecosystems, Beaudry and Laurence Solar-Pelletier provide more details on these concepts.[105]

We then characterise the four main types of ecosystems – knowledge, entrepreneurial, innovation, and business ecosystems – to accurately position innovation ecosystems as key to linking S&T to innovation and its impact.

Precursor concepts leading to ecosystems

The concept of *industrial districts* emerged from Alfred Marshall's seminal work in the late 19th century.[107] He observed that neighbouring small businesses in the same industry could take advantage of cost savings, shared access to resources, and the mobility of a skilled labour force, all enhanced by geographic proximity. Strong social networks and shared values within these districts foster cooperation and informal communication, while promoting competition, which drives innovation and efficiency. This socio-economic model, revitalised by Italian scholars in the 1980s,[108, 109] remains influential in understanding how local industry structures contribute to competitive advantage through collective learning and mutual trust, as emphasised by Laurent Scaringella and Agnieszka Radziwon.[110]

Innovative milieus, another European concept,[kk] expands on the idea of territorial innovation beyond small industrial districts. They emphasise the social and institutional fabric of a region as a crucial determinant of its innovative capacity.[111] Unlike industrial districts, where firms are considered the main drivers of innovation, milieus are conceptualised as proactive agents that shape the innovation process. This framework emphasises the importance of geographical proximity and informal social networks that enable knowledge sharing and cooperation. However, as highlighted by Dimitri Uzunidis,[112] innovative milieus are more flexible than industrial districts. They encompass firms of various sizes and sectors, highlighting the significance of collective learning in fostering innovation.

[kk] Developed by the Groupe de Recherche Européen sur les Milieux Innovateurs (GREMI) http://wwwa.unine.ch/irer/Gremi/accueil.htm

The concept of *clusters*, first proposed by Michael Porter [113] in the early 1990s, has gained significant traction as a key topic in regional innovation discourse. Clusters are geographically concentrated groups of interconnected companies and institutions that operate within a specific field and benefit from the synergies generated by their proximity.[114] Porter emphasised the dual role of clusters as sources of competition and cooperation. They are essential to fostering innovation and improving regional competitiveness.[115] In France, they are known as *pôles de compétitivité*. Clusters differ from industrial districts in their size and complexity, frequently including larger corporations, educational establishments, and public authorities. Rui Baptista and Peter Swann [116] demonstrated that clusters are not just about horizontal integration, but also about the vertical integration of various players in the value chain. They enhance innovation by sharing resources, knowledge, and collaborative relationships. Additionally, the presence of universities within clusters significantly expedites the generation of new ideas and the emergence of innovative companies. The clusters imagined by Gérald Tremblay, who served as Minister of Industry, Commerce, Science and Technology from 1989 to 1994, and then as Mayor of Montreal, are a classic example of the concentration of innovative companies in a small geographical area around R&D institutions.

In parallel, the concept of *innovation systems* or *systems of innovation*, first coined by Chris Freeman,[117] broadened the focus to encompass interactions between a wide range of institutions, including firms, universities, research centres, and governments, that collectively drive technological development. As suggested by Bengt-Åke Lundvall,[118] the systemic nature of innovation is emphasised by crucial relationships between public and private actors that lead to the creation, modification, and diffusion of new technologies. While National Innovation Systems (NIS) focus on how country-wide institutional structures support innovation, their subnational counterparts were introduced by Philip Cooke, Mikel Gomez Uranga, and Goio Etxebarria [119] as Regional Innovation Systems (RIS). The latter is a concept closely akin to clusters, used to analyse regions and their specific innovation dynamics. Expanding upon Van De Ven's 'infrastructure for entrepreneurship', Olav Spilling [120] also introduced the concept of a local 'entrepreneurial system'. These types of systems highlight the importance of geographical proximity in facilitating cooperation and establishing a shared regulatory and institutional framework that fosters innovation.

> From systems of innovation to innovation ecosystems:
> 'While [the theory of systems of innovation or] SI helps "policy makers develop approaches for enhancing innovative performance in the knowledge-based economies" (OECD, 1997), [the theory of innovation ecosystems or] IE was developed to "help executives anticipate the managerial challenges of nurturing the complex business communities that bring innovations to market" (Moore, 1996). While both theories analyse interactions in networks, IE is focused on the development of business analysis in order to develop business strategies. On the other hand, SI is dedicated to understanding the flow of information and knowledge related to the technological development of a nation or specific region.'
> — Nihad Faissal Bassis & Fabiano Armellini (p. 1064)[121]

Different types of ecosystems

Building on these earlier concepts of innovation clusters and systems, ecosystems offer a dynamic and integrated perspective on innovation in today's economy. As one of the first to

develop the ecosystem analogy after Michael Rothschild in 1990,[122] James Moore [123] emphasised the dual role of collaboration and competition, commonly referred to as 'coopetition', in driving collective value creation and innovation within ecosystems. Marco Iansiti and Roy Levien [124] further added that ecosystems extend beyond the boundaries of specific industries or regions, comprising various actors, including firms, research organisations, universities, policymakers, and consumers. Ecosystems hence differ from previous concepts, as they emphasise interdependencies and the co-evolution of actors, a point that is highlighted by Mirva Peltoniemi, Elisa Vuori, and Harri Laihonen.[125]

Business ecosystems, as first conceptualised by James Moore [123] in 1993, involve heterogeneous organisations that co-evolve through interactions around a central firm – a concept somewhat related to the clusters' anchor firm. These organisations, while competing in some areas, also collaborate to create value that no firm could achieve alone. Business ecosystems thus extend beyond traditional industry boundaries, often encompassing firms from different sectors that contribute complementary skills and resources.[3] In a subsequent book, Moore[126] specified that the primary objective of business ecosystems is value capture, with firms working together to enhance their competitive advantage while adapting to changes in the broader economic environment.

Depending on the context and level of analysis, other ecosystem types and theories emerged as a consequence of Moore's seminal work. Closer to research and science lies the **knowledge ecosystem**, first introduced by Bart Clarysse et al.[127] The concept focuses on the generation and dissemination of knowledge, particularly in pre-competitive environments.[128] As highlighted by Catherine Beaudry and Laurence Solar-Pelletier,[105] universities, public research institutions, and other knowledge-intensive organisations play a central role in these ecosystems, which prioritise early-stage research and technology. Knowledge ecosystems are often seen as distinct from innovation and business ecosystems, as the knowledge generated within these networks may eventually lead to commercialisation and the development of new technologies, new business models and even industries. The interaction between knowledge ecosystems and other types of ecosystems, as described by Nihad Faissal Bassis and Fabiano Armellini [121] and Katri Valkokari [129], highlights the complex, multilayered nature of modern innovation processes, where basic research feeds into applied research, technology, innovation, and commercial exploitation.

Innovation ecosystems, as described by Ron Adner [130] and Deborah Jackson,[131] focus primarily on the creation of value through the development of new products, processes, or services. These ecosystems rely on a broad network of actors – including firms, research institutions, governments, and intermediaries – collaborating to push the boundaries of innovation.[127] Unlike business ecosystems, which prioritise value capture and competitive advantage, innovation ecosystems foster collective learning and facilitate the diffusion of new technologies.[3] In this sense, as stressed by Annabelle Gawer and Michael Cusumano,[132] innovation ecosystems build on the concept of business ecosystems, where 'the value co-creation process is set to create more value for the ecosystem's end users, together, than the individual players could generate as independent actors'.

> ‘An innovation ecosystem can be viewed as the sum of connections of businesses, typically in a region or industry, including key actors in supporting sectors such as academia and government, that influence innovative performance.’
> — Jan Youtie, Robert Ward, Philip Shapira, Sandra Schillo, & Louise Earl (p. 255)[14]

Originating from similar building blocks, **entrepreneurial ecosystems** are closely related to knowledge and innovation ecosystems. The components of the ecosystem and the local context significantly influence the choices and decisions of entrepreneurs. Entrepreneurial ecosystems strive to establish conducive environments that foster the emergence of new businesses and rapid growth companies, encompassing the establishment of innovative start-ups and the expansion of existing businesses.

Entrepreneurial and innovation ecosystems are intricate systems with several shared traits: self-organisation, complex components, interconnected relationships between various stakeholders, non-linear dynamics, and adaptability. Both types of ecosystems encompass a multitude of actors and factors interacting at various levels. Additionally, each ecosystem fosters collaboration between startups and established corporations. Innovation is central to both innovation ecosystems and entrepreneurial ecosystems; however, not all entrepreneurs engage in innovation, and not all innovations stem from entrepreneurial opportunities. Paola De Bernardi and Danny Azucar [133] note that although both ecosystems involve similar actors, there are differences in the roles that these stakeholders play in each ecosystem.

Another key distinction highlighted by Ben Spigel [134] is their geographic characteristics. Entrepreneurial ecosystems are often place-based, suggesting that proximity between actors is crucial for success. In contrast, David Audretch and Maksim Belitski [135] argue that innovation ecosystems can operate across broader, non-geographic boundaries, especially in the digital innovation landscape. Having emerged naturally from the concept of clusters, entrepreneurial ecosystems hence represent a collection of actors that interact within a geographically bounded entrepreneurial environment, and factors that contribute to the development of productive entrepreneurship.

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In essence, ecosystems can be categorised into four main types: **knowledge ecosystems** generate value through knowledge, **innovation ecosystems** leverage this knowledge to create value, **entrepreneurial ecosystems** focus on creating value from new businesses, and **business ecosystems** capture the value created from innovation. Knowledge ecosystems foster the emergence of concepts, studies, initiatives, publications, patents, and technologies. These elements undergo transformation within innovation ecosystems, giving rise to innovations, such as new products or revolutionary business strategies. It is the responsibility of the players in business ecosystems to monetise and market these innovations, thereby capturing their value.

Paavo Ritala and Argyro Almpanopoulou [78] certainly contend that the ecosystem approach provides valuable perspectives for designing innovation policies, highlighting the importance of interdependence and the co-evolution of actors within a dynamic and open system.

Annex B
Examples of Innovation-Related and Performance Indicators

Catherine Beaudry
Marie Gruber

For decades, scholars and STI policymakers and analysts have used different types of indicators to measure various facets of innovation performance. The long history of the *Oslo Manual*[ll] bears witness to this measurement effort. Before delving deeper into the specific fields of application within 4POINT0, we first present some of the most commonly used indicators.

In line with these criteria, various widely used innovation indicators offer insights into distinct aspects of innovation performance and allow for analyses from different perspectives (an extensive list of indicators is provided by Marisa Dziallas and Knut Blind [136]). For instance, among the most common indicators mentioned by John Hagedoorn and Myriam Cloodt,[137] **R&D intensity** by companies measures the ratio of R&D expenditures relative to revenue or GDP. It is a key metric of the *Oslo Manual 2018* for comparing innovation efforts across organisations and countries. Keith Smith,[138] however, suggests that this indicator can be misleading, as it often fails to capture non-R&D-based innovations, such as those in services or low-tech sectors, where innovation might be process- or design-oriented rather than R&D-intensive. Efforts to coordinate collaborative research and co-innovation activities between various stakeholders within an ecosystem or between industrial sectors will likely fall under the radar of this indicator. Yet, innovation activity metrics such as R&D expenditures or intensity are pertinent to both innovation ecosystems and knowledge ecosystems.

Patent counts and **patent citations** have been vastly used, over decades, in scholarly publications, as indicators that reflect invention activity and intellectual property (IP) protection, and the influence of these inventions on technological advancement, respectively.[139-145] While these metrics are heavily relied upon in academic and policy settings, patents do not necessarily correlate with commercial success and may overemphasise innovation in high-tech industries while overlooking less formalised knowledge, such as that in low-tech sectors. **Technology transfer and licensing revenue** track income generated from IP licensing, capturing the commercial and societal value of innovations.[146] Again, the extent to which licensing revenue reflects broad innovation impact is debated, as these metrics may skew toward organisations with high licensing capacities rather than those with impactful innovations that are not easily monetised.[147]

[ll] The OECD and Eurostat published these manuals in 1992, 1997, 2005 and 2018.

The **new product sales ratio** measures the percentage of revenue from recently developed products, offering insight into an organisation's ability to bring innovative offerings to market – an especially relevant metric in fast-paced industries.[148] Jakob Edler and Jan Fagerberg [149] argue that the new product sales ratio can misrepresent innovation performance in sectors where innovations focus on incremental improvements or service enhancements rather than new product development. This makes the indicator less suitable in industries with a low emphasis on rapid product turnover. **Innovation revenue** and **product novelty indexes** assess the market success of new products and services, indicating an organisation's ability to meet and anticipate market demands.[102]

Collaboration and network indicators reflect the increasing role of open innovation and cross-institutional partnerships. Metrics such as co-invention and R&D alliances reveal knowledge-sharing activities that drive cross-disciplinary and cross-sectoral innovation.[150] While these indicators highlight knowledge-sharing activities, they often fail to capture the depth and quality of these collaborations, potentially overstating the impact of partnerships without assessing the outcomes and value of shared knowledge.[151] Simply counting collaborations or co-authored publications does not reveal how effectively these partnerships contribute to innovation. Additionally, **innovation productivity** – the ratio of outputs (e.g. patents, products) to inputs (e.g. R&D spending) – assesses the efficiency with which resources are transformed into innovations.[140] The metric has been criticised for failing to consider external factors, such as regulatory changes or economic conditions, which affect productivity but are unrelated to innovation efficiency itself. Also, output-focused metrics may miss process or service innovations, which are harder to quantify.[152]

A final noteworthy indicator is **time to market**, which measures the speed at which new ideas or technologies are commercialised, indicating agility and responsiveness in competitive sectors. While it indicates agility and responsiveness, it has been criticised for promoting short-termism, where the emphasis on speed may result in prioritising incremental over breakthrough innovations to reduce time to market.[153, 154]

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