

Autocatalysis in Rural Entrepreneurship: The Case of PEAK Sunnfjord

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Abstract. This paper employs ecological principles and entrepreneurial ecosystem theory to analyse, describe and conceptualise the dynamics of a rural start-up ecosystem in Western Norway. We present the idea of a set of autocatalytic processes that we argue are crucial and distinct to entrepreneurial ecosystem process theory. We also argue those processes are key to understanding and stimulating regional entrepreneurial growth. The study uses qualitative semi-structured interviews of actors within the ecosystem. In total, we draw a picture of a business ecosystem's evolutionary processes and dynamics. We argue that vibrant entrepreneurial ecosystems are not dependent on the conditional and agglomerative factors in the region (urban attributes) but can emerge only based on a set of initial conditions that can exist regardless of location. Based on our findings, we offer policy guidelines and future research avenues.

Keywords: entrepreneurial ecosystem; longitudinal analysis; rural entrepreneurship; autocatalytic processes

1 Introduction

There is generally less entrepreneurial activity in rural compared to urban areas. Such differences can occur due to varying access to financial and human capital, as well as governmental support (Korsgaard, Müller, and Tanvig 2015; Korsgaard, Ferguson, and Gaddefors 2015). Despite many of these hindrances to rural entrepreneurship, there are also advantages to be found. For example, employees in rural areas may be more loyal and contribute to stability more than their urban and mobile counterparts (Pallares-Barbera, Tulla, and Vera 2004). The cost of living and renting offices also tend to be lower in rural areas. Many rural and natural characteristics may also be appealing to certain lifestyles (Korsgaard, Ferguson, and Gaddefors 2015). On the other hand, rural areas are more dependent on successful entrepreneurs than before. Rural entrepreneurship can be seen as a way to reduce poverty and migration, and to develop the labour markets outside of cities. Over the last two decades, researchers have increased their attention to the problems that occur in the wake of increased centralisation (Ansari et al. 2013). In general, entrepreneurship provides opportunities to stimulate economic activity, employment and higher standards of living in rural areas.

How do thriving entrepreneurial environments emerge? Previously, rural areas have been synonymous with fewer opportunities than urban areas. This perception is mainly based on limited access to capital, qualified talent pools, poor infrastructure, and thinner environments from which entrepreneurs can harvest critical resources and knowledge (Frimanslund 2022). These are still challenges in many rural areas, but to a lesser extent than before (Ansari et al. 2013; Müller and Korsgaard 2018; Pato and Teixeira 2016; Frimanslund and Nath 2022). Technological developments in the last two decades mean that entrepreneurs do not have to migrate to cities to build successful growth firms.

Even if the opportunities are present, thriving entrepreneurial environments do not emerge by themselves. In order to understand how such emergence may happen, we need to have a clearer image of what such an environment is and what it consists of. Previous and notable literature on, and theory about, industrial clusters and regional innovation systems do not mention the interactions between entrepreneurs and their stakeholders (Asheim, Smith, and Oughton 2011; Asheim, Cooke, and Martin 2006; Mason and Brown 2014; Porter 1998). More recent approaches aim to explain the interplay and dynamics within a geographic area (Isenberg 2011; Stam 2015; Spigel 2017). The academic interest in entrepreneurial ecosystems has increased rapidly in recent times, and ecosystems have gained the status as a “buzzword” for both research and policy (Wurth, Stam, and Spigel 2021). Although the concept is intuitive, it is challenging to clearly define what an entrepreneurial ecosystem is, or to present a clear description of the dynamics that play out within such an environment.

Entrepreneurial ecosystems can be described by differentiating between top-down and bottom-up creation. In a bottom-up perspective, the environment is the result of the entrepreneurs and their actions (Katz and Corbett 2018, 161). In order to understand how entrepreneurial ecosystems emerge, a bottom-up approach should help us understand the system’s internal dynamics. For lack of a clear and unified perspective on ecosystems, more research on characteristics is needed to fill in the gaps (Wurth, Stam, and Spigel 2021; Frimanslund, Oklevik, and Kwiatkowsky 2022; O’Connor and Audretsch 2022). In this study, we will attempt to address a system’s self-sustaining characteristics by asking the research question of which dynamics are characteristic of vital, self-organised and self-governed ecosystems. Such characteristics may of course be dependent on a variety of factors, as described in existing literature in business management, entrepreneurship and innovation, policy, regional development or economic geography. Therefore, in order to find a representative ecosystem for our study, we focus on a rural case where we assume that emergence and growth are less associated with conditional factors such as agglomeration, population, industrial density, institutional and organisational strength, as well as surrounding financial environments.

The case of our study is the seemingly successful and vital rural entrepreneurial ecosystem of PEAK Sunnfjord in Førde, Norway. The local area employs 11,000 people. Here, the environment of PEAK has been established and is driven by entrepreneurs (or “key actors”, according to Spigel and Harrison (2018)), now housing approximately 30 companies such as start-ups, mature and related stakeholders. They aim to facilitate a structure that stimulates creativity and interactions between all the actors. Their external characteristics follow a modern and popular model of start-up clusters that can be observed in most developed urban environments around the world. There are several attempts to recreate such environments in rural areas as well, but due to the lack of human and financial capital, such attempts rarely prosper beyond the level of an office hub.

This study aims to learn more about the dynamics that make a rural environment prosper. As other potential rural cases are beyond the scope and capacity of this study, we have chosen to employ a single-case design and have used qualitative interviews with a range of actors that adhere to and represent the classification of Spigel and Harrison (2018). The following section presents the underlying theoretical perspectives. In the following section on methodology, we explain and justify our research design. We then present our findings, analysis, conclusions, followed by a section discussing what practitioners can learn from this study.

2 Literature and theory

Although some major steps have been taken in recent years, the entrepreneurial ecosystem has been criticized for being confusing and not sufficiently unifying. This has resulted in a lack of consensus or a shared definition (Wurth, Stam, and Spigel 2021; Stam and Van de Ven 2021). The concept is appealing to several research traditions, such as strategic management, entrepreneurship and regional

development (Acs et al. 2017). In particular, the boundaries between entrepreneurial ecosystems and innovation systems are unclear (Spigel 2017). Entrepreneurial ecosystem theory may appear to be something new, but despite its rich history, it lacks predictability regarding certain elements, such as internal dynamics. Instead, a large part of the current theory emphasises the combination of social, political, economic and cultural elements within a region (exogenous variables) that support productive entrepreneurship (Pocek 2022; Frimanslund, Oklevik, and Kwiatkowsky 2022). Additionally, the internal dynamics (exogenous mechanisms) are left for further study, perhaps due to the complexity and accessibility of appropriate data (Frimanslund, Oklevik, and Kwiatkowsky 2022).

The oldest concepts of industrial ecosystems can be traced back to the industrial districts of Marshall (1919). Among the concepts that resonate with entrepreneurial ecosystem theory are the synergies of agglomerated factors and located actors. The same concept can be found in cluster theory (Porter 1998), regional innovation systems (Asheim, Smith, and Oughton 2011) and triple helices (Etzkowitz 2008). Marshall argued that there are forces outside the organisation that support and promote industrial growth. Yet, despite Schumpeter's monumental influence in the research field of innovation and entrepreneurship, systemic approaches to specifically explain entrepreneurship would not arise until later. One of the first systemic approaches to entrepreneurship that can be directly compared to contemporary entrepreneurial ecosystem theory appeared in the late 80s, when debates regarding the social and economic structures of entrepreneurship received increased attention (Spigel and Harrison 2018). Dubini (1989) defined ecosystems or start-up environments as the presence of family firms, role models, a diversified economy, a strong business infrastructure, available investment capital, an entrepreneurial culture, and a public policy that allows for early phase finance. Perhaps somewhat overlooked in the recent literature, Moore (1993) argued that firms should focus on *seed innovations that can lead to revolutionary products* and that the success of business ecosystems are the result of predatory relations to other systems. In retrospect, his 1993-paper in Harvard Business Review used much of the same language as modern ecosystem literature, although the contemporary language may appear to sound more collaborative than predatory. Such ideas culminated in the work of Daniel Isenberg (Isenberg 2011, 2010) who, among others, sparked the recent development growth of the literature on entrepreneurial ecosystems.

But why view PEAK Sunnfjord through the lens of entrepreneurial ecosystem theory, and not as a traditional cluster or regional innovation system? This is an important question in this paper, and it thus warrants a closer discussion.

- The theory of industrial clusters (Porter 1998) posits that economic activity has a natural tendency to form in specific geographic areas. The co-location of such industries allows for economies of scale and scope, as well as the inclusion of wider supply chains and mutually dependent firms within a specific region. Industrial clusters do not necessarily focus on start-ups, but include the wider range of industrial actors within a region.
- Regional innovation systems aim to explain and promote innovation in a region (Asheim, Smith, and Oughton 2011; Asheim and Gertler 2005). Innovation has in general been viewed as a condition for economic growth, and therefore justifies the rather large amount of attention it has received in the literature. Regional innovation systems introduce the role of the public in transferring knowledge and technology from actors such as universities or between industrial sectors. Thus, innovation system thinking has undeniably been highly influential for policy development over the past 20 years (see e.g. OECD 2017). Similar to cluster theory, regional innovation systems emphasise the importance of social capital, networks and learning within an evolutionary framework. Further, clusters are normally included in the innovation system. The weakness of regional innovation systems is their lack of emphasis on entrepreneurs (to paraphrase Schumpeter, the ones who can realise innovation). In the last 10-15 years, we have seen a sort of democratization of innovation activities, such as the emergence of start-up hubs

and crowdfunding. These processes are directly tied to entrepreneurship. Therefore, we need better ways to understand both individual and systemic entrepreneurship in particular.

- Entrepreneurial ecosystem theory is, as mentioned above, not completely in agreement about the dichotomy of actors and factors, and the inclusion of both aspects tends to complicate matters and lead to some confusion. For both aspects, the entrepreneur is the focal point (not agglomeration or innovation). This means developing taxonomies or explanations of the actors (Spigel and Harrison 2018; Colombelli, Paolucci, and Ughetto 2019) and mapping the factors (Isenberg 2011). Several advances include both aspects (Xie, Xie, and Martínez-Climent 2019; Bruns et al. 2017; Stam and Van de Ven 2021). However, very few address the internal dynamics (Auerswald and Dani 2017 is a notable exception). For our purposes, we want to look at the internal dynamics between the actors in a system, and the literature is not as developed in this area.

Table 1: A comparison of related theories

Theory	Main actors	Main output
Industrial clusters	Wider supply chain or mutually dependent firms within a geographic region (firms, customers, suppliers, related industries, etc)	Economies of scale and scope. Synergies and lower transaction costs between actors
Regional innovation systems	Public institutions for research and knowledge transaction, industries, business-oriented services	Innovation
Entrepreneurial ecosystems	Key start-ups, spin-offs and recruited start-ups, investors, support agencies, and other stakeholders	Entrepreneurial activity

There is a connection between these theoretical concepts (Hammer and Frimanslund 2022). Each of these theoretical perspectives argue that the competitiveness of the firms is related to the resources that are available within the region. On the other hand, in a rural area, there will be a scarcity of industries, let alone industrial clusters and regional innovation systems. Start-ups may therefore be left without appropriate knowledge and policies to support them in such regions. However, ecosystem theory has not reached the point where it can sufficiently guide rural development where agglomerated resources are not yet present. For this to be possible, we need more knowledge on the dynamics in nascent and small ecosystems in such deprived areas.

How can we then describe the dynamics of a self-organising and self-governed entrepreneurial environment? So far, we have been discussing roots in the literature and related systemic approaches. There are, however, well-known theoretical dynamics that can be helpful for how we regard rural ecosystems. These include agency theory and the relations between the actors in the ecosystem. Additionally, as we have briefly mentioned, there is agglomeration theory, which explains how the organisation of resources and actors within a small environment can foster benefits. Finally, we will introduce the concept of autocatalytic processes to explain why some environments (small and large) grow and others do not.

Agency theory (Jensen and Meckling 1976; Eisenhardt 1989a; Wright, Mukherji, and Kroll 2001) addresses the relationship between actors. In our case, this typically refers to an investor and a start-up (Van Osnabrugge 2000). The varying motivations and motives for entrepreneurs compared to mature firms (Landström 2017) and the informational asymmetry gives rise to a range of challenges relevant to ecosystem research.

Similar and related to cluster theory, agglomeration addresses the benefits of firms being within proximity of each other (Acs and Varga 2005). However, agglomeration differs from cluster theory in

the sense that it is not limited to an industrial context. Agglomeration assumes a density of factors such as human and financial capital, but both these aspects are lacking in rural contexts outside of ecosystems. Nonetheless, we make use of agglomeration theory to understand how the gradually built-up human and financial capital (“*smart capital*”) within start-up ecosystems can be distributed to others, and thus strengthen the ecosystem as a whole.

We have chosen these theoretical approaches because they help us explain and understand how the internal dynamics of ecosystems play out. Despite this, however, we are unable to say anything about how these dynamics play out over time, and why some ecosystems become vital regional drivers while others remain weak (Spigel and Harrison 2018). The novelty of this paper is in its introduction of the concept of *autocatalytic processes* to ecosystem research. To understand this concept, we turn to chemistry. Here, it refers to a self-enforcing reaction where the reaction is catalysed by the product of the reaction itself (Bissette and Fletcher 2013). Autocatalytic processes happen in every aspect of nature (Ulanowicz 1997), and to apply an ecological perspective to entrepreneurial ecosystems (see different discussions in Auerswald 2015; O’Connor and Audretsch 2022) means to view ecosystems as extensions of nature. A bridge between autocatalytic processes in chemistry and economics has been made in the past (Padgett, Lee, and Collier 2003), and may increase their relevance to the internal dynamics of entrepreneurial ecosystems. To present an example: positive effects (such as the exit or buy-out of a start-up) may relieve the founders of their obligations to the start-up, putting them in a position in where they can relocate and reinvest their acquired human and financial capital and time in new, related projects. Such reinvestments or recycling of ecosystem resources (Spigel 2017) will be self-enforcing for the system, strengthening it. Note that this is merely a representative example. Autocatalytic processes have been used to explain how business cycles appear and how industrial clusters are formed (Matutinović 2005), albeit not in the context of evolutionary entrepreneurship.

This concludes the presentation of the theoretical foundation for our study. The following section presents the empirical methodology used to explore these issues in a suitable rural environment.

3 Methods

As our objective is to examine the internal dynamics of an apparently vital, self-organised and self-governed start-up environment in a rural location, we face a few limitations. First of all, such cases are rare. Second, lacking a clear definition, we need to make the claim that our case is large enough to be considered an “ecosystem”, thus giving it transferable value to the literature. Third, as the number of participants in such an ecosystem is limited, and because we want to examine a set of currently unknown internal dynamics, we are inclined to employ a qualitative and exploratory design (Gehman et al. 2018).

Simultaneously, we use theory to look for certain dynamics. We thus argue that we are using both inductive and deductive approaches. First, we want to identify the internal dynamics at PEAK. The inductive approach means that the researcher enters the environment with an open mind and subsequently analyses data. However, an analysis that is guided by theory (similar to theory testing) adheres to a deductive approach. Section 2 identified clear gaps in the literature related to the internal dynamics of entrepreneurial ecosystems, but we still elaborated on a few theoretical concepts that may highlight our particular case data. Therefore, we may proceed to move continuously between interview data and theory, an approach known as abduction (Dubois and Gadde 2002).

This case methodology allows the researcher to uncover a deeper level of comprehension of a phenomenon, and is therefore appropriate for understanding how entrepreneurial ecosystems are managed (Yin 2013; Eisenhardt and Graebner 2007; Gehman et al. 2018).

We collected data by conducting semi-structured interviews. As mentioned above, the number of possible informants was limited and the selection needed to be representative for the taxonomy of ecosystem actors (Spigel and Harrison 2018). The semi-structured interview format enables us to use the theoretical insights in our data collection while still exploring the case with an open mind. The interviews were conducted during the spring of 2022 with seven informants. Those informants were all representatives of founders, key actors and stakeholders in the environment (Langley 1999; Eisenhardt 1989b). Non-essential informants were not included in data collection. The first round of interviews was conducted at their premises, and follow-up interviews and questions were conducted via Zoom or email during the spring. Since qualitative data is not meant to be generalised, our main objective was to gather data that can be transferable to other contexts (Guba 1981).

Table 2: List of informants.

Informant	Role	Label	Interview duration
1	Fund manager	Investor	1 hour
2	Founder/CTO (key actor)	Founder 1	45 min
3	Founder/CEO (key actor)	Founder 2	1 time
4	Founder/investor	Founder 3	45 min
5	Founder	Founder 4	1 hour (Zoom)
6	Public support agency/board member, investor	PSA 1	1 time
7	Public support agency/CEO	PSA 2	30 min

The data analysis was conducted as follows. Larger bodies of text data can be challenging to analyse without an analytical strategy (Yin, 2013). First, the interviews were transcribed. We then employed a variant of thematic analysis strategy (Miles and Huberman 1994) that allowed for theory guidance (Eisenhardt 1989b; Alvesson and Kärreman 2007). Although the Eisenhardt method recommends having several cases, it is still suitable for single-case studies such as ours. The data was boiled down to aggregated factors or variables using a first and second-order coding structure. The data analysis resulted in 68 coded quotes that were grouped into a coding structure. These will be presented in the next section.

4 Findings

This section presents the three main findings. The findings are three levels of a structure that we believe hold the key to supporting the vitality and self-organising properties of entrepreneurial ecosystems in rural areas. These are 1) infrastructure and the presence of actors, 2) entrepreneurial capital, and 3) autocatalytic processes. The section concludes with a conceptualisation of ecosystem vitality.

4.1 Infrastructure and actors

PEAK Sunnfjord is viewed as being a modern start-up hub at the centre of the region. The informants refer to the location as appealing and natural. The physical properties of the office may be taken for granted, but this was frequently highlighted as being important. One reason for this lies in that the concept is owned by the founders, which enables shared objectives for the office.

Without this way of organising, we would have been an ordinary tenant, and he a landlord, with diverging objectives. Therefore, you must always agree on terms and make contracts. We now share the same vision (Founder 2)

Further, most of the informants mention technology as a common denominator, as well as the need for developers, support and finance. In addition to the facilities, the selection of firms and supporters that can share resources critical to these common denominators is preferred. These resources are elaborated on in the next subsection.

4.2 Entrepreneurial capital

The factor and level of entrepreneurial capital in the data is divided into 1) financial capital, 2) social capital, and 3) human capital.

4.2.1 Financial capital

Financial capital refers to economic means measured in money, and includes everything from grants to buy-outs. Several of the informants state that being part of the community at PEAK motivates and improves ease of access to financial capital. This is primarily due to close proximity, which counteracts the disadvantage that would otherwise be present in a rural location. Entrepreneurs at PEAK can access investment funds and private investors that rural start-ups normally would seek out in urban environments. Conversely, fund managers use their networks to seek out promising investment cases.

After all, it is the networks here that we have developed over time, in our role as an early-phase investor, that matter. They let us find the resources we believe can contribute to the companies that we have invested in (Investor).

Furthermore, the investors in the environment have allocated financial capital specifically for founders during their start-up phase. Alongside the presence of the regional office of Innovation Norway, the main national support agency, the entrepreneurs mention that they have better access to start-up finance. The following quote underline the importance of this, and also presents an interesting example of the improvement of information asymmetry according to agency theory.

By sitting next to the support agencies, it is easier for me to pick up exciting opportunities. That can mean trade fairs, courses, grants and general information. Useful information comes flowing to us (Founder 3).

It is worth noting the origin of much of the start-up and growth capital in the environment. Several of the interviews mentions that some of the successful entrepreneurs have chosen to reinvest their acquired wealth into other start-ups in the environments. This may happen directly, or via a founders' fund titled PEAK Venture. This will be elaborated on in section 4.3.

“PEAK Venture is capitalised by many of the people inside these walls. Both entrepreneurs and investors [...]. It follows the model at Startuplab [in urban Oslo], and is quite unique (Investor).

4.2.2 Social capital

The term social capital is used to describe resources that are available to actors through active participation in social networks. PEAK enables the sharing of a relatively large amount of social capital.

An advantage of meeting people in the hallways is that you are being introduced to different networks (Founder 3).

[...] daily interactions lower my threshold to talk to everybody I know, and to reach the competencies that are in my immediate vicinity (Investor).

To the outside world, PEAK is “just” an office hub, but it facilitates these networks of sharing. This appears to be something unequivocally positive for the informants. The reason seems to be that the facilities are designed based on entrepreneurial needs, and not retroactively fitted to suit such needs. Some of the informants describe the interaction as “holistic”. This means that the environment at large decides how each part plays out. It further appears that the branding of PEAK is appealing to entrepreneurs and stakeholders. The brand signals the ecosystem’s interactions and ambitions.

PEAK has become a brand. That makes recruitment processes easier. People want to be part of the community (Founder 1).

4.2.3 Human capital

Human capital is used to describe the number of qualifications, skills, knowledge and talent among the workers. In this context, human capital refers to the human resources within the environment.

There is a large variety of skills here. That makes it unique. One of our success factors is that we have managed to connect founders in early phases, firms close to IPOs, and public or semi-public support agencies. That makes the whole thing work (Founder 2).

This issue may be stereotypical, and not unique, to modern start-up environments, namely the presence of both successful and non-successful entrepreneurs that are willing to share their experiences, resources and networks within in an appealing locality. According to the informants, the participants value openness and acceptance of failure. One of the key actors mentions:

The resources are available. You have the support agencies, in-house investors, nascent entrepreneurs, and a unicorn on the second floor. You have the whole spectrum. You can go and talk to someone who lifted a company up from zero to a couple of billions if you want to. He’s available. Or you can ask someone who has made it on a larger scale. From zero to a million, or fifty (Founder 2).

In conclusion, we have identified and grouped three kinds of capital that are crucial to start-up environments. These factors are not necessarily unique to this study but are also found in the related and extant literature. Therefore, they will not be more thoroughly expanded upon here.

4.3 Internal dynamics and autocatalytic processes

Autocatalytic processes are self-enforcing reactions that can describe the dynamics in an entrepreneurial ecosystem. The processes enhance reaction times and increase the vitality of the ecosystem. What this means, and what factors facilitate such processes, will be presented in this subsection.

4.3.1 Presence and access

One of the informants describes their presence at PEAK in the following.

*To be at PEAK is to be at a seminar. Or actually - breaktime at a seminar
(Founder 3).*

This factor relates to the presence of, and access to, *entrepreneurial capital* between the *actors* within *the infrastructure* as previously covered. The factors are therefore quite commonplace and intuitive, but still important. As some of the informants pointed out, presence in the ecosystem led to opportunities and jobs that they would not get without being there. This is a fundamental condition before autocatalytic processes can occur.

Recruitment is a central topic. This can be the most crucial challenge in fast-growing companies (Investor).

In conclusion, the presence of, and access to, actors and resources increases the reaction time of not only direct interactions and dynamics, but also the products of these interactions and dynamics. Consequently, this leads to self-enhancing mechanisms in the ecosystem.

4.3.2 Self-enhancing mechanisms

One interesting finding is how internal competition is described. One of the interviews revealed that PEAK has been criticised for facilitating internal competition over employees. This may lead to a sort of cannibalism of human capital. The informant, however, says the advantages outweigh the disadvantages, because this enhances the appeal of the environment and increases the performance of the firms.

There has been some criticism that our firms have been taken employees from their neighbours in the environment. I don't see the issue. Yes, you may lose an employee, but then you have to work harder to keep the good heads. If a person in my company wants to quit, I may be the one who has failed (Founder 2).

Internal competition in the environment is described as a source of strength for each firm. Another finding is that the core actors work as role models and increase the ambitions of the other companies. These dynamics are rare in rural locations but can be put into an ecosystem.

You will not see this many other places in Norway. There are urban examples, but not any rural ones (Founder 2).

A public support agency describes the processes as follows.

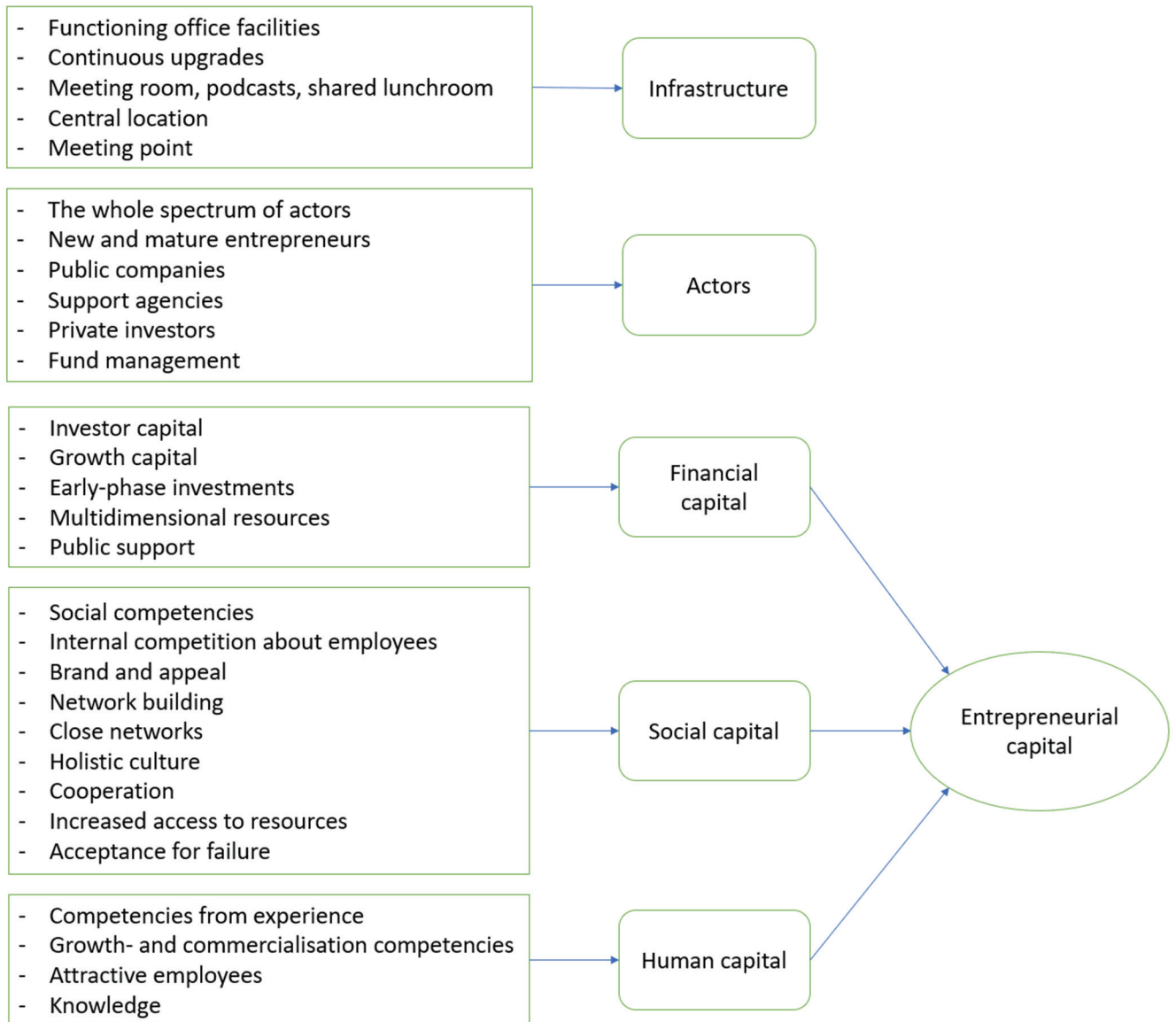
We are the kind of people that hit the pool balls, and then the balls go off in some direction. We tend to have some sort of involvement in many such situations here. What we do is to act as catalysers. We don't make the car go, but we can make it go a little faster and better. We do that a lot (PSA1).

This quote is a representative of the category of self-enhancing mechanisms in the entrepreneurial ecosystem. Another informant describes the public role as follows.

I forgot to mention (PSA1). They are central to this place. They facilitate and keep the public contact. They oil the machinery (Investor).

4.4 Illustration of the data structure

Overall, the following figure sums up the selected first-order codes and grouped second-order themes. This is a presentation of the selected, representative and raw data alongside the aggregated factors. These factors will be analysed and further conceptualised in section 5.



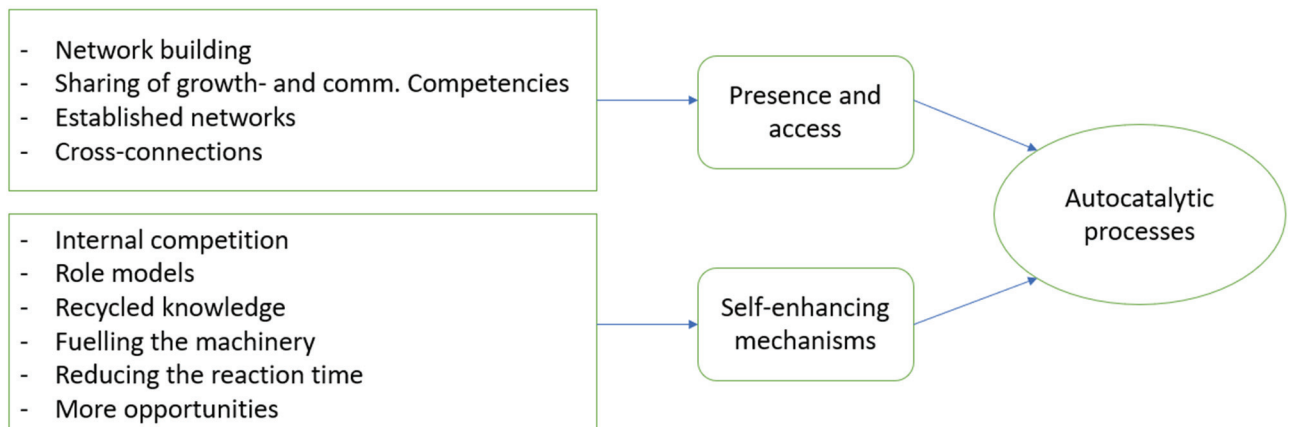


Figure 1: Data structure.

5 Analysis and conceptualisation

The factors from section 4 will now be conceptualised and discussed in light of the theory from section 2. Finally, our findings will be discussed in light of policy and practitioner implications.

Our approach, examining entrepreneurial ecosystems, illustrates one of the challenges of ecosystem research. As explained previously, ecosystems can be viewed as the regional factors that support productive entrepreneurship. In our case, the ecosystem is viewed as being something very different from much of the current mainstream literature, but it adheres to the process theory of Spigel and Harrison (2018). Our approach is more concrete and limited to a defined environment. Overall, 1) infrastructure, 2) actors, 3) entrepreneurial capital, and 4) autocatalytic processes form four distinct layers of ecosystem vitality. For rural districts and policy-makers, this provides four steps towards utilising the entrepreneurial potential of a region.

5.1 Infrastructure

Like its urban counterparts, the environment at PEAK is presented as appealing. Our informants seem to thrive and enjoy the environment and appreciate the facilities provided by the key actors. The environment seems to be adapted to the needs of growth-oriented, technology-oriented and capital-intensive start-ups. The infrastructure is not unique to the literature, but it is similar to the *material attributes* of entrepreneurial ecosystems as described by Spigel and Harrison (2018).

By comparison, regional innovation systems also involve infrastructure for innovation, but this refers more to relational structures between institutions and actors (Asheim, Cooke, and Martin 2006; Asheim, Smith, and Oughton 2011). Like regional innovation systems, the office walls of PEAK do not place definite boundaries for the environment. One can be connected to the environment but not located inside PEAK's walls. Further, the infrastructure of the environment cannot be considered as anything other than a sandbox for playing, testing and growing. For interactions to take place, the sandbox needs to be filled with players.

5.2 Actors

Interactions depend on actors. The type of actors present is crucial to their dynamics. In regional innovation theory and cluster theory, the lack of focus on entrepreneurs has given rise to publicly governed start-up hubs in many rural areas (Jakobsen et al. 2017). Despite good intentions, the lack of entrepreneurial key actors in their environments do not allow for bottom-up dynamics to arise (Spigel 2019). A lesson for policy-makers is to learn from contemporary entrepreneurial ecosystem theory, and to try to facilitate bottom-up growth, or "*fuel the machinery*" as one of our public support agency informants described it.

The composition of actors in the environment is a characteristic of ecosystem theory, and seems to be crucial to the system. Conversely, cluster theory specifies geographic concentrations of connected firms and institutions within certain sectors or fields (Nathan 2019; Delgado, Porter, and Stern 2010; Asheim, Cooke, and Martin 2006). Our findings may be interesting in the sense that the common factor of the firms is not within certain industrial sectors, but in their ambitions and entrepreneurial status. It seems clear that ecosystem theory is also a cluster perspective adapted to the entrepreneurial context. However, an important difference is how ecosystem theory claims that there are internal (Spigel and Harrison 2018) and even biologically inspired (O'Connor and Audretsch 2022) dynamics that arise within the system. Much of this remains undiscovered, but we argue that one key to understanding those mechanisms lies in the next two layers of entrepreneurial capital and their autocatalytic dynamics.

5.3 Entrepreneurial capital

The theoretical fundamentals for entrepreneurial capital is dominated by the transaction cost theories presented in section two, especially Agency Theory (Jensen 1986; Jensen and Meckling 1976). The degree of informational asymmetry can also help describe the internal dynamics of entrepreneurial ecosystems (Frimanslund, Oklevik, and Kwiatkowsky 2022; Frimanslund and Nath 2022). Furthermore, access to financial, social and human capital may be described using agency theory at PEAK.

One of the dynamics is that the environment is promoting the actors' performance. This is highlighted by the popular nature of the ecosystems (Feld and Hathaway 2020; Feld 2012). One can imagine that the environment follows certain marketing principles of individual firms, and that the creation of creative, appealing and vital working environments is something that key actors may do better than publicly owned and governed start-up communities in rural areas. It has previously been mentioned that such environments may have motives other than entrepreneurial growth, such as regional relocation of workers and families, regional attractiveness, and fighting regional decline (Frimanslund 2022).

5.4 Autocatalytic processes

After 1) the first level of infrastructure is constructed, and 2) the environments contain a certain range of actors, and 3) the actors acquire entrepreneurial capital, those resources can 4) be recycled into new ventures. The main contribution of this study is to highlight how those resources catalyse these reactions, and how their products give rise to new interactions. This is a self-enhancing mechanism of entrepreneurial ecosystems that demands further examination. Such examinations warrant evolutionary and processual research designs, as well as a close consideration of which measures to use. Furthermore, cross-contextual and quantitative data is needed to definitively determine whether this case and whether its dynamics are representative of ecosystems in general.

Autocatalytic processes are self-enhancing reactions in which the product increases the next reaction (Bissette and Fletcher 2013). Typically, such processes will be slow in the beginning and then speed up their development over time. This is transferable to entrepreneurial ecosystems. Spigel and Harrison (2018) previously conceptualised the growth and decline of such ecosystems, but an understanding of how those dynamics occur demands further examination. Our findings point to the distribution of entrepreneurial capital as described above, as well as the way in which they are set in motion within the system. That motion is further fuelled and catalysed by public support agencies within the system.

Thus, the self-enhancing mechanisms in our findings point to an internal competition, which means that the companies both share and compete over resources. This is strikingly similar to how Matutinović (2005) described autocatalytic processes in an economic context. The processes stimulate competition,

which leads to higher efficiency and performance of the actors, as well as a higher number of role models. Consequently, the resilience of the entire ecosystem is strengthened.

We are now able to see the contours of a model that describes and explains the vitality of entrepreneurial ecosystems as seen in Fig. 2.

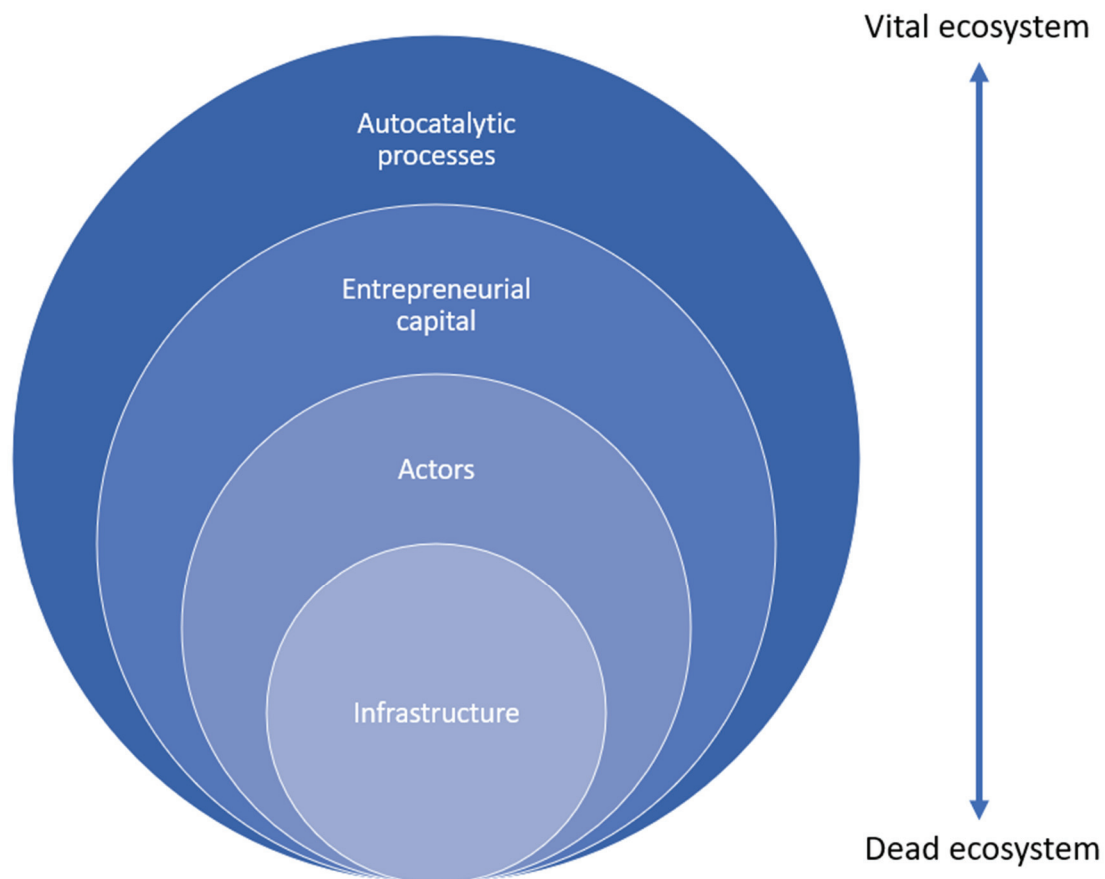


Figure 2: Conceptualisation of ecosystem vitality.

With this model, we have summarised and contextualised the factors that emerged from our data. The elements are consistent with theory, but now also offer a novel explanation for how an ecosystem can and should emerge according to bottom-up principles (Spigel 2019). The model can be taken as a guide to ecosystem vitality for policy-makers and industries that aspire to strengthen their environments.

According to the model, each step needs to be present before the next one can emerge. One cannot have autocatalytic processes in an ecosystem without it acquiring entrepreneurial capital. This capital must also be possessed and shared by the actors (Isenberg 2010; Feld and Hathaway 2020). The actors need to be located within an infrastructure. This acknowledgement opens a new implication for policy-makers. Logically, it follows that the vitality of ecosystems is a time-consuming process. For example, many incubator programs aim to establish the necessary infrastructure for start-ups in rural areas. It may take several years for start-ups to grow and acquire critical resources. When those resources are available, they can only be recycled and redistributed if the key actors own and govern the ecosystem. If not, they may depart from the system. This leads us to Fig. 3, which illustrates the timeline and encourages policy-makers to be patient.

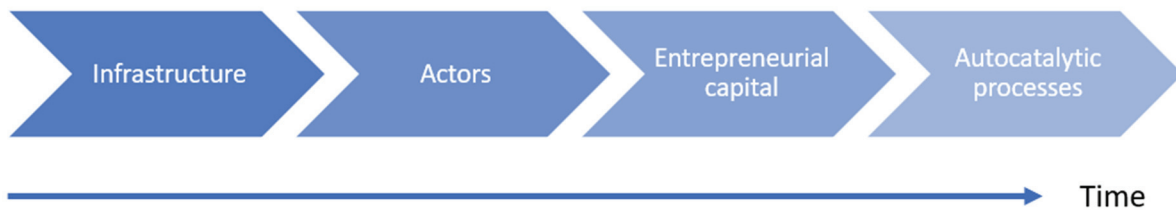


Figure 3: Ecosystem vitality and time.

6 Conclusions

The aim of this study is to explore the internal dynamics of entrepreneurial ecosystems and to acquire new insights of how it develops. Based on a case study of a rural best case, we were able to identify and conceptualise four main levels of a system's vitality, as seen in Fig. 2.

The main contribution of the study is to illustrate how a vital ecosystem is differentiated from other entrepreneurial clusters that fail to achieve self-sustaining dynamics. These mechanisms have been overlooked in the literature of systemic entrepreneurship.

The study is mainly limited by its single-case design. We believe that our findings are transferable to other start-up environments, but more research is needed. This includes other case studies and operationalisation of our factors to quantitatively determine the identified levels and dynamics.

If valid, our findings offer a clear-cut guide for policy-makers who aspire to stimulate regional development and establish entrepreneurial ecosystems. This implies that one may have to depart from the tradition of regional innovation system policies set up to create top-down and publicly owned systems with potentially regional and political objectives. Instead, the goals of such systems must be aligned with those of the entrepreneurial actors in order to motivate their internal autocatalytic dynamics.

Many of our findings are in line with emerging and present ecosystem theories. However, some of our findings contradict theories about entrepreneurship. In particular, rural best cases show that productive entrepreneurship can occur in places not predicted by agglomeration theory, as well as aspects of ecosystem theory that assume a density of certain factors in the surrounding region. Future research should examine these mechanisms and look for empirical support.

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