

The Dynamics of the Development of a Knowledge Ecosystem

Kristina Grumadaite and Giedrius Jucevicius

Vytautas Magnus University, Kaunas, Lithuania

kristina.grumadaite@vdu.lt

giedrius.jucevicius@vdu.lt

Abstract: This paper presents and analyses the dynamics of the development of knowledge ecosystem, putting more emphasis on interorganisational context, such as industrial clusters or “geographical concentrations of interconnected companies, specialised suppliers, service providers, companies in related industries and associated institutions (trade / industry associations, universities, educational institutions) that compete but also cooperate” (Porter 2000). This paper contributes to scientific efforts to minimise the gap of research on organisational entities whose development reflects the essence of an ecosystem – a network of interacting actors, which compete and cooperate in order to create and apply new knowledge on the grounds of self-organisation. This paper, following a dynamic approach to the development of knowledge ecosystems, analyses four development stages, the preconditions behind the viability of knowledge ecosystems and their interconnections.

Keywords: Knowledge ecosystem, Development, Dynamics, Viability preconditions

1. Introduction

A knowledge ecosystem in its nature is a self-organising dynamic and adaptive system, in which all the processes of knowledge creation, sharing, using, managing take place on purpose to enhance knowledge (Öberg & Lundberg 2022). Its development accordingly goes through different stages while applying different dynamics modes – for example, Chiles, Meyers and Hench (2004) defined fluctuation dynamics, positive feedback dynamics, recombination dynamics, and stabilisation dynamics. Thus, the research of knowledge ecosystem requires a dynamic and complex approach, while revealing the emerging phenomena during each stage of the system’s development. However, the static approach based on the analysis of statistical data about the development of such systems or application of the outsider’s view into the development processes still prevail in the scientific literature. Accordingly, it results in the formulation of the following research questions – what are the stages of different dynamics of knowledge ecosystem development? What are the main features and preconditions of the development of knowledge ecosystem?

Thus, this paper adapts the dynamic approach into the development of knowledge ecosystems and *aims* to define and analyse both the dynamics and their preconditions of the development of knowledge ecosystem. It follows the approach that an ecosystem moves through different stages of its development while applying new manifestations with a need to implement particular decisions to make this process as smooth as possible (Grumadaite, Ceicyte, Bernotaite & Brazinskas 2022; Lichtenstein & Plowman 2009; Uhl-Bien & Arena 2018).

The first part of the paper reveals the concept of knowledge ecosystem through the lenses of interactions. The following parts of the paper present the dynamical nuances of different development stages and preconditions to make particular dynamics to happen. These preconditions are based on the empirical research results of industrial clusters in Lithuania those develop their clusters as knowledge ecosystems.

2. Knowledge Ecosystem as a Network of Interactions

Following complexity theory, which analyses how relationships impact the emergence of collective behaviour (Sammut-Bonnici 2015) knowledge ecosystem is a network of various actors implementing different types of interactions based on defined simple rules, values and behavioural standards in order to adapt to the environment, to learn continuously, and to develop trust, identity and responsible behaviour (Anderson 1999; Obolensky 2014). The actors of knowledge ecosystem manage various knowledge processes – they generate and share knowledge by effectively using knowledge generation and sharing tools, they storage knowledge and apply it into decision making processes and professional job-related activities (Zaim, Muhammed & Tarim 2018).

According to Aarikka-Stenroos and Ritala (2017), the ecosystem approach includes competition and evolution, emergence and disruption, stable business exchange and value co-creation. It means that in the case of knowledge ecosystem the main value is knowledge, and multiple actors participate in knowledge co-creation. One should note that knowledge co-creation is impossible without interactions. The types of social interactions by Nisbet (1970) consist of cooperation; conflict; social exchange, related to mutual benefits; coercion and conformity. Conflicts can be seen as a consequence of competition, and social exchange can be manifested in the process of cooperation. Conformity as a form of social interaction, according to Nisbet (1970), is not obedient

behaviour due to authoritarian actions, but behaviour to meet group expectations, for example, to follow certain values and standards of behaviour. Thus, one could conclude that an ecosystem is a network of actors interacting with each other and with the external environment, where because of the absence of control through communication, coordination, obedience to common values and norms of behaviour, competition, cooperation the ecosystem is able to be viable, co-evolving and adapting to external environment.

3. Dynamics Variations of Ecosystem During its Development

Scientific literature emphasises different stages of development of ecosystems, starting from the first initiating event to boost tension to the emergence of a new order based on self-organisation and self-regulation, when the ecosystem returns to stability following defined rules and behavioural norms (Anderson & Russell 2011).

Emergence of non-equilibrium

In general, scientific literature that analyses systems that are based on self-organisation, emphasises the importance of tensions at a starting stage of its development. They state that the greatest changes occur when the system is close to the *edge of chaos* or at the very point of edge of chaos (Boal & Schultz 2004). The first stage is called fluctuation dynamics (Chiles, Meyer & Hench 2004), initiating conditions (Plowman et al. 2007), dis-equilibrium state (Plowman et. al. 2007; Lichtenstein & Plowman 2009), emergence of non-equilibrium state (Jucevičius, Grumadaitė, Jucevičienė & Čeičytė 2019).

Non equilibrium is caused by various factors, that could be defined as *triggers* (Uhl-Bien et al., 2007), which can be planned or unplanned. Often the unplanned changes can be related to the development of external environment, and this development causes the need to acquire, accumulate and apply knowledge while attracting new actors and new resources. For example, the tension may occur because of emergence of a big competitor or many more competitors in a particular sector, merging of other enterprises, or in the opposite- a bankruptcy of an anchor enterprise as it happened in cinema industry in Lithuania. Losing a source of knowledge or seeing someone with a significant amount of knowledge may encourage to develop a new ecosystem with unique accumulated knowledge. In order to make it happen, a response as an initiative for further development of an ecosystem should occur.

Scientific literature reveals different strategic approaches, applied in the stage of non-equilibrium. Grumadaitė and Jucevičius (2022) define strategic approach of experimentation, strategic approach of external agent and strategic approach of ad hoc fellow professionals. Strategic approach of experimentation is based on taking advantage of opportunities without a clear expected outcome; thus, knowledge ecosystem is developing while using mistake-trial method. Strategic approach of the external agent, in the opposite, sees the initiators of development of the ecosystem having a clear expected outcome regarding the ecosystem and accordingly a clear plan regarding the further development of the ecosystem. Finally, the strategic approach of ad hoc fellow professionals emphasises the timely natural gathering of like-minded people and achieving common goals without thinking about formalised forms of cooperation (Ibid.).

One should state that in this stage the communication and cooperation happen only among a group of the main initiators, which communicate and cooperate together. In order to develop the knowledge ecosystem and invite new participants, additional tools are needed because the outsiders and initiators of the ecosystem may have no trust towards each other. Quite often the outsiders may even don't feel any urge to get united because they don't see any danger to come and/or expect to maintain the same direction as nothing happened. Thus, scientific literature emphasises the importance of strengthening non-equilibrium or amplifying actions (Plowman et. al. 2007; Lichtenstein & Plowman 2009).

Strengthening non-equilibrium

Naturally, strengthening non-equilibrium is related to various uncertainties, that are increasing. In the case, when the state of non-equilibrium is created deliberately in order to initiate particular changes, the reactions of all the involved may vary, from intensive discussions and sharing thoughts even with conflictual notes, until a tensed silence. In order to avoid being moved to a higher-level chaos or to return to a previous state with no changes, the following preconditions should be met:

- *Setting simple rules* (Plowman et al. 2007; Uhl-Bien et al. 2007; Palmberg 2009). In the ecosystem there is a variety of interacting actors that mostly are dependent only on local information (Anderson 1999). Thus, simple rules help them to maintain freedom in the actions but to follow common system's rules at the same time (Lichtenstein 2016). These rules reflect the vision, strategy, the best

practices of the system. Authority in the system or system's identity also works as simple rules (Obolensky 2014).

- *Setting main values and principles.* The ecosystem mostly maintains natural-regulation and stabilisation based on self-referencing values and principles that aren't pushed from outside (Chiles et al. 2004). The values could be related to risk taking and tolerating uncertainty; learning; adaptation to new events; cooperation and sharing in order to emphasise the importance of unity and efforts to avoid individualism and competition (Grumadaitė, Jucevičius & Staniulienė 2022).
- *Existing conditions for experimenting and innovating regarding to knowledge processes.* Since non-equilibrium state is related to the highest level of innovation, the conditions for experimentation and fluctuation should be implemented (Lichtenstein & Plowman 2009; Palmberg 2009).
- *Promotion of interactions in the system.* This precondition is related to the statement that the ecosystem is impossible without interactions (Laihonen 2006), thus, interactions inside and with an external environment should be encouraged and promoted in order to share and create knowledge (Lichtenstein & Plowman 2009; Palmberg 2009).
- *Spreading sense of events and vision* (Plowman et al. 2007; Palmberg 2009). Organisational experience reveals that the most active ecosystem's members used to highlight the advantages of working together even in the face of various uncertainties, even bankruptcy. The highlighting of aims to be fulfilled in the ecosystem and clarification of the expectations of ecosystem's members are also applied.

Those preconditions should lead to emergence of community feeling and dependency to the ecosystem, and in other words – movement to the *continuous two-way emergence of a new order* (Jucevičius, Grumadaitė, Jucevičienė & Čeičytė 2019) that is directly related to self-organisation state (Plowman et. al. 2007; Lichtenstein & Plowman 2009).

Continuous two-way emergence of a new order

In this stage, various interactions without centralised control take place, such as:

- Participation in joint learning activities: it also helps to get acquainted and explore the possibilities for future joint activities.
- Communication: representing (knowledge) community in various representative events and creating new contacts, organising joint regular meetings, communicating in informal settings – all that helps to create teams.
- Competition: working on projects with separated research areas or on development of new projects that are not in the area of direct competition.
- Coordination: it is expected that coordination of ecosystem is depending on the ecosystem's members themselves since there are no control outside.
- Cooperation: the ecosystem's members are creating joint activities and projects in order to develop new knowledge and or find new ways of its sharing, storage, etc.
- Compliance: to define simple rules, values and behavioural norms.

The empirical research of nine industrial clusters in Lithuania that formed naturally on a purpose to cooperate and create innovative products, such Cinema cluster, Game industry cluster, Tourism cluster, Machinery cluster, ICT cluster, Wellness cluster, Cluster of medical innovations, Photo electronics cluster and Laser cluster was performed while adapting multiple case research strategy (Yin, 2014) and conducting interviews with industry cluster coordinators – the individuals who see the cluster as a whole. The research was dedicated to the analysis of various factors regarding industrial cluster development dynamics and its preconditions. Starting with the questions about the beginning of the development of knowledge ecosystem, further questions reflected the need to analyse *the cluster viability*, which can be measured by the quantity (increase in the number of members) and quality (activities) in the cluster.

The respondents were asked about admission of new members into an emerging ecosystem, such as How the admission of new members to the cluster looks like? What are the admission criteria (in some cases, clarifying questions are provided, for example, whether a member who is new to the market and unfamiliar to the cluster members can be accepted)?

Later, the focus in the interviews is moved to the area of interactions, such as communication, cooperation, competition. The respondents were asked the following questions: How the process of communication and cooperation is ensured in the cluster? Are there competing companies in the cluster? If so, how is the problem

of competition solved? Are the members of your cluster more likely to act individually? If so, how is this solved? Do cluster enterprises feel like a community of common destiny, where the actions of one person / enterprise affect the whole cluster? What values are dominant in the cluster? How is trust maintained in the cluster? How is the learning process ensured in the cluster?

Research results revealed that in some cases the local development of knowledge ecosystems is limited because of a limited number of actors in a particular sector: “barely few new enterprises over the next twenty years” (Laser cluster). Reasons of such a slow industrial growth, that is related to a creation of unique products could be defined as follows:

- limited number of users: the main users are universities to whom unique products are created;
- the uncertainty of the final result, which implies that industry enterprises are not attractive to venture capital providers;
- a high demand of highly skilled workers who can create start-ups, and it takes time for new professionals to gain knowledge to develop their activities.

However, an increase in the number of enterprises in the industry is not necessarily a prerequisite for ecosystem’s growth. On the contrary, some interviews even claimed that the ecosystem had reached the limit of the number of their members. According to the coordinator of Game industry cluster, the industry has a limited number of companies that can enter the developing ecosystem: “We do not see promising members that we can accept. It is not interesting to have people in the list or companies in the list – you need to have them for the activities”.

Human resources – a skilled workforce – have a strong influence on the development of both industries and ecosystems. A scarcity of skilled work force was mentioned by the coordinators of both creative industries clusters and Machinery cluster. The coordinator of Tourism cluster highlighted another problem - a problem of keeping trained employees in cluster enterprises, because sometimes these employees simply leave.

Thus, the research revealed the areas of viability of developing knowledge ecosystem those have influence on the dynamics of knowledge ecosystem: *Actions regarding the admission of new members*, *Criteria regarding selection of new members* and *Preconditions behind the active involvement in the ecosystem* (see Figure 1).

As it can be seen in Figure 1, *Using external funding* was of significant importance for the dynamics of development of the ecosystem especially by facilitating the development of R&D infrastructure, joint trainings, participation in public events. However, the main emphasis will be put on the admission of new members and their involvement into the activities of the developing knowledge ecosystem.

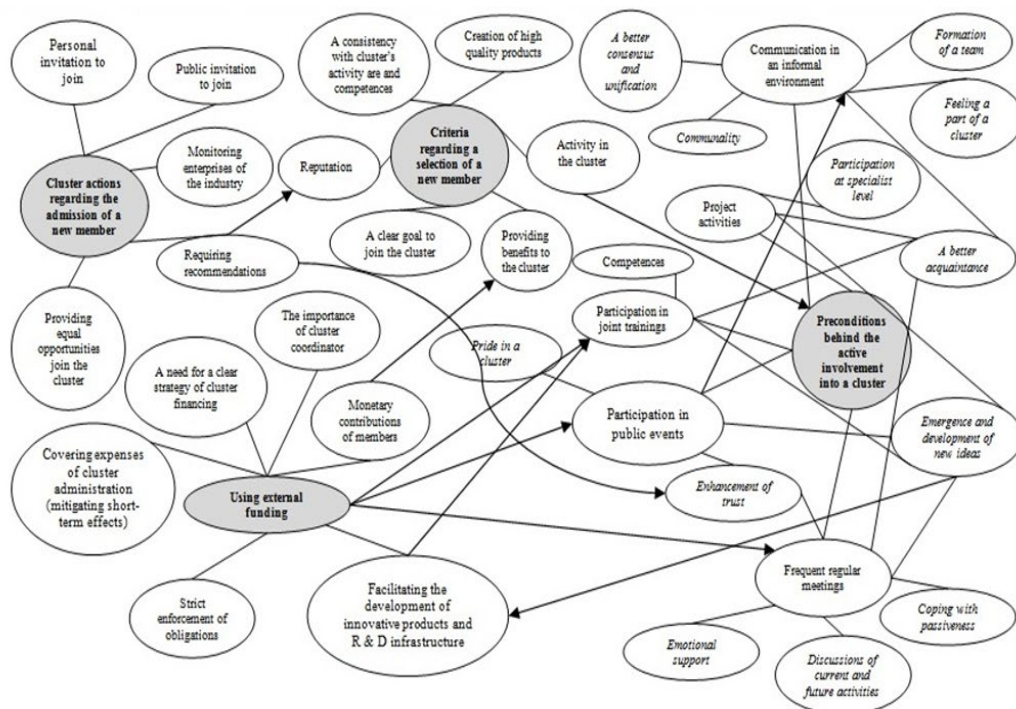


Figure 1: Dynamics and Viability Preconditions of the Knowledge Ecosystem (prepared by the Authors)

Purposeful admission of new members. New members are carefully selected because analysed clusters are oriented towards higher productivity, innovation and access to larger markets, and thus ecosystem's growth is based on quality rather than quantity. The purposeful acceptance of members is highlighted in every single interview. According to the interviews, a potential enterprise should meet the following criteria.

- *To be in accordance with ecosystem's - cluster's activity areas and competencies.* In the case of analysed clusters, a potential enterprise must seek to achieve more than the most of the same industry-based enterprises: "we position ourselves a little higher, that we can, we have bigger goals" (Cluster of medical innovations), especially if the cluster was created to develop innovative products: "Our cluster was created to develop health innovative products and services; if a new member just promotes a healthy lifestyle or is simply a SPA centre, he will be unfit for us" (Wellness Cluster).
- *To develop high-quality products which, for example, meet certain standards* (this is especially important to Machinery cluster, because cluster enterprises would not be allowed to enter international value chain without these standards).
- *To have a good reputation.*
- *To have a clear goal regarding joining the cluster*, in other words, to clearly understand its functions: as the coordinator of Cinema cluster told, "just to be here - there is no such goal".
- *To not limit themselves by getting benefits from a cluster but also provide benefits to the cluster* i.e. complement the cluster with resources and products – "knowledge, people, contacts, products, services", as well monetary investments.
- *To be active in cluster activities:* an enterprise should be focused on cooperation (Cinema cluster).

It is obvious that it is important to know about a particular enterprise as much as possible in order to choose a new member that meets the selection criteria (see Figure 1). As the amount of enterprises that belong to a particular industry is relatively small, enterprises in the industry know about each other quite well, thus one of the naturally occurring processes is a self-sustaining monitoring of the industry through performing activities and providing a personal offer to join the cluster, as in the case of the Cluster of medical innovations: "If we see that there is a company in Lithuania that does a little bit more than others do, or that company meets our ... our common goal ... then we just offer them, they hear our story who we are, what we are about". Similarly, in the case of the ICT cluster, when a cluster enterprise finds out that there is an enterprise that is beneficial to the cluster: "You go, talk to them, and then they get involved". Therefore, the recommendations of cluster enterprises are of great importance to the acceptance of new members, in particular due to the increased trust of that enterprise from the side of remaining members of the cluster. For example, a poorly provided service by a new member may be detrimental to the image of the whole cluster.

However, the most of clusters are open to all actors on the market; if it becomes clear during a conversation with the cluster coordinator that the candidate meets the criteria for the field of cluster's activity, product quality, reputation, providing benefit to cluster and other criteria, he may become a cluster member.

Active involvement in the knowledge ecosystem. In order to make a cluster active and viable, cluster members must engage in cooperation activities. A part of these activities are self-organised meetings between groups of enterprises in order to deal with various business issues. In some cases, an enterprise organises a meeting of all members of the cluster if this enterprise wants to report certain news, for example, to present new service, and the enterprise then "initiates a meeting, and then we all arrive, if we can". Sharing of functions and responsibilities is also being observed in analysed clusters: "some of them are more responsible for marketing, others may be more responsible for development, the third one is more responsible for science and business cooperation"; these functions can be appointed both by cluster members themselves or by a cluster coordinator in order to bring "benefits both to the cluster and to the environment".

Based on the analysis of the interviews, one could distinguish four types of activities that contribute not only to greater involvement in the cluster, but also to better acquaintance with each other, increasing trust and finding new ideas even with limited previous experience of cooperation, as follows:

- frequent regular meetings;
- communication in an informal environment;
- project activities;
- participation in public events;
- participation in joint trainings.

Frequent regular meetings according to cluster coordinators serve as means for a better acquaintance to each other, events, work results; discussions of current and future activities; coping with passiveness; emergence and development of new ideas; enhancement of trust; emotional support (also see Figure 1). In some cases, meetings happen quite naturally when enterprises share some common interests with each other, for example in the case of one of high-tech clusters, "there is constant communication between the labs, the people who work in the labs, and the companies." In Photo electronics cluster some enterprises meet "maybe once a week, and three or four - twice a week." In other clusters, frequent regular meetings are planned by cluster coordinators. Although such meetings can be held flexibly as needed ("we look roughly when we already have some knowledge, news, ideas, many meetings are organised and held regularly at least "six times a year", depending on the field of activity and the need to meet. Sometimes clusters simply follow the practice to organise regular meetings no matter the intensity of news: "even if there is a first impression that there is not much to talk, after meeting it becomes clear that there is something to talk about, new ideas and new thoughts are born, and then something new is born". Cluster coordinators reveal that "we gather and talk about our pains, our troubles, our joys". Such frequent conversations, if they are based on sincerity, also become a means of increasing trust: "we have many beautiful and diverse statistics, how trust is born depending on how many times a week you communicate with that person".

Communication in an informal environment serves as means for a better acquaintance, seeking consensus and unity; formation of a team; development of community feeling. Informal communication includes not only coffee-breaks but also various trips to spend time in an informal environment, for example, in the nature. High technology cluster and Cluster of medical innovations created a tradition to organise annual gatherings (including conferences) of all employees of cluster members-enterprises, even including their family members (see Figure 1). For example, in the case of the tourism cluster, in addition to the aforementioned weekly meetings to share joys and worries, the practice of visiting different companies of the cluster is applied: "we try to make that informal communication as well - we go to some specific companies of our cluster members". Visiting cluster companies by rotation is also a feature of the Wellness cluster - it helps to "feel each other" and "get other results".

Empirical research results revealed that *participating in projects* gives an opportunity to cluster members to get acquainted with each other at specialist level. Based on the interview with the coordinator of ICT cluster, projects help to learn about each other's opportunities and capabilities to take responsibilities, develop new ideas, and discover new markets and new areas for future activities. In addition, participation in public events (including conferences) enhances pride in a cluster and identification with it: "Yes, we are all here together, we did this, look here, this and that has been done". A trip to a particular destination also may become a tool for informal communication: "Through these trips, many different ideas are born, people are talking, gathering together, and there is already a stimulus: we will do something, there is a need to do something". Participation in public events may also act as a means of enhancing trust. A cluster member, who has successfully completed the tasks assigned to him to make new contacts, to bring and share the necessary information and knowledge with other cluster members, to represent the whole cluster, etc., deserves their trust.

Social capital is also developed through participation in joint training online and especially in a defined physical space, where participants of training not only develop their competences but also get acquainted with each other and discover new opportunities (see Figure 1).

Finally, at any time, the ecosystem returns to the state of **stabilisation** that is understood as a natural regulation process, which is understood as continuously following the rules or returning back to rules and values, when there is too much experimentation.

4. Concluding Remarks

This paper emphasises the variety of interactions that occur in the development of knowledge ecosystems – networks of actors that initiate and implement knowledge generation, sharing, storage and adaptation processes. In general, the development of knowledge ecosystems starts with the initiation and strengthening non-equilibrium which leads to a stage of the creation of a new order based on self-organisation and self-regulation.

Empirical research with nine industrial clusters revealed various interconnections between members that are worthy to enter the developing ecosystem and various aspects related to the involvement of the ecosystem's members. This empirical research revealed a context of the development that is emerging itself and still is not the most suitable for the smooth emergence of knowledge ecosystem. For example, there is a scarcity of skilled

work force that is emphasised as one of the most important preconditions for the emergence of an ecosystem. Enterprises that belong to analysed clusters create products, which require much knowledge and creative abilities.

Since gaining independence from Soviet Russia, many Lithuanian industries had created or recreated themselves from the scratch, thus sometimes the industries may be in the development stage. The scarcity of various resources creates a need to attract external funding. External funding contributes not only to softening short-term effects (compensation of administrative expenditures) but, even more - facilitating development of innovative products and R & D infrastructure. On the other hand, the scarcity of cooperation traditions and trust may result in issues of fierce competition, individualism and passiveness in mutual activities. However, the research results shouldn't be adapted only to post-Soviet context because the analysed context in general reflects any development of knowledge ecosystem that needs to start since beginning because of various circumstances. In such a case empirical research results provide practical insights for the active engagement into the development of knowledge ecosystem and what could be interconnections and consequences of various tools, including frequent regular meetings, communication in an informal environment, project activities, participation in public events and participation in joint trainings.

However, a deeper analysis is needed in order to develop a theoretical framework regarding the dynamics of development of knowledge ecosystem. This dynamic could be revealed through knowledge dimensions, such as Socialisation, Externalisation, Combination, and Internalisation, or Nonaka's SECI model (Bratianu 2010), including the mechanisms to overcome competition, individualism and passiveness regarding knowledge sharing. Although cluster coordinators can reveal many facts about the dynamics in the development of knowledge ecosystems, however, the empirical analysis from the perspective of the ecosystem's members is needed to reveal the process dynamics of the development of knowledge ecosystem.

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