

Smart Development Principles of Knowledge Ecosystem in an Industrial Cluster

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Abstract: This paper presents and analyses the principles to develop a knowledge ecosystem in the case of an industrial cluster – “a geographical concentration of interconnected companies, specialized suppliers, service providers, companies in related industries and associated institutions (trade / industry associations, universities, educational institutions) that compete but also cooperate” (Porter, 1990). In the scientific literature, knowledge ecosystem is relatively recent and less explored concept, which is mostly defined as a network of geographically co-located actors, primarily centred around a local university or another research organisation for knowledge search and creation (Almpanopoulou, 2019; Clarisse et al., 2014). Because industrial clusters are putting an emphasis on product commercialisation and creating value (business or innovation ecosystem), the development of knowledge ecosystem more or less reflects a quite fragmental point of view – it is sometimes understood simply as having an university or a research institute among the cluster members and organising particular training seminars, while cluster members may remain individualistic and passive regarding mutual knowledge sharing and creation (Jucevičius, Grumadaitė, Jucevičienė and Čeičytė, 2019). However, in this paper knowledge ecosystem is understood as a precondition of innovation and business ecosystem in order to deal with complex and wicked problems (Andersson and Törnberg, 2019). In addition, smart development is explored expanding digitalisation boundaries, while understanding a social system through the dimensions of agility, network-based, sustainability, learning, innovativeness (Jucevičius and Jucevičienė, 2017).

Keywords: knowledge ecosystem, smart development, industrial clusters, development principles

1. Introduction

The scarcity of knowledge and competence is defined as one of tensions that encourages the enterprises to join various cooperation forms, including industrial clusters (Jucevičius, Grumadaitė, Jucevičienė and Čeičytė, 2019). Scientific literature emphasises that the most successful are those systems, which reflect the concept of self-organisation based biological *ecosystems* that are deeply embedded into a particular context and thus are able to adapt to every changing conditions (Filotas et al, 2014; Messier et al, 2015). Accordingly, following this concept of ecosystem, management literature analyses the essence of business ecosystem, industrial ecosystem and related ones (Adner, Oxley and Silverman, 2013; den Hartigh and Tol, 2008; Lu, Rong, You and Shi, 2014; Moore, 2006; Valkokari, 2015). *Knowledge ecosystem* as a concept gains more and more attention with a theoretical and practical need to focus on knowledge enhancing activities, such as knowledge sharing and knowledge development (Öberg and Lundberg, 2022).

The importance of knowledge sharing and knowledge adaptation became extremely important during COVID-19 pandemic times, when business enterprises have required innovative solutions and the creation of new order, and sense making (Rubin and de Vries, 2020; Uhl-Bien, 2021). These solutions are related not only to the adaptation of novelties of Information and Communication Technologies, which is often understood as a smart quality in the scientific literature, but also with various so called “soft” aspects that require to adapt different approaches and perspectives. According to Jucevičius and Grumadaitė (2014), smart development of an ecosystem is about “stimulating its relations and interactions in non-linear and non-hierarchical ways”, facilitating the self-organisation and emergence of the system out of multiple interactions. Jucevičius and Jucevičienė (2017) also emphasised that smartness of a social system includes eight dimensions, while digitality is only one of them together with agility, network-based, sustainability, learning, innovativeness, intelligence and knowledge-driven. Thus, in the paper this expanded concept of smartness is adapted while answering the formulated *research question*: what are the principles behind the development of knowledge ecosystem through the lenses of smartness?

This research question has risen out of theoretical and practical realisation that despite the importance of knowledge, knowledge sharing and acquisition of different knowledge forms is still challenging. The trials of

developing knowledge ecosystem may be very fragmental without taking into account the importance of the connections and relationships among the elements.

Accordingly, *the aim* of this paper is as follows: to define and to analyse smart principles of knowledge ecosystem development.

The first part of the paper reveals the concept of knowledge ecosystem, its processes and structural parts through the lenses of smartness. The second part represents the context of industrial clusters in Lithuania regarding knowledge ecosystem development. Finally, the third part presents development principles of knowledge ecosystem.

2. Knowledge ecosystem essence: structure and processes through the lenses of smartness

As any *complex adaptive system*, a knowledge ecosystem is a network of interactions based on competition, cooperation, coordination, communication and compliance (Anderson, 1999; Di Paolo and De Jaegher, 2012; Laihonen, 2006). These interactions are maintained by a variety of agents with different functions and roles without a centralised control from outside – thus, knowledge ecosystems are self-organising (Anderson 1999; Brenner and Mühlig, 2013; Laihonen, 2006). Knowledge ecosystem is following common values, simple rules and standards of behaviour (Dashwood, 2014; Edgren and Barnard, 2012; Gunningham and Rees, 1997; Mason, 2007). In the complexity theory these rules, values, standards and models are defined as attractors, which allow the ecosystem to return back to the equilibrium (Boal and Schultz, 2007).

Because of variety of interactions and compliance to common values and behaviour standards a new order is continuously created and knowledge ecosystem keeps developing. Thus, these parameters can be considered as *primary parameters*. It can be stated that because of these primary parameters being in place, knowledge ecosystem acquires *the secondary parameters*, such as identity, adaptation, coevolution, non-linearity, viability, trust and responsible behaviour.

One should emphasise that knowledge ecosystem has a clear sense of *identity*—values, traditions, competencies, culture, and core beliefs—and every action is self-directed, so there are no reactive or uncertain actions (Mason 2007). Due to all the mentioned characteristics, the system is *dynamic* and *vital* (Plowman et al, 2007).

Following behavioural norms and values helps a knowledge ecosystem to exhibit *responsible behaviour* in interactions both within the system and with the external environment (Anderson and Russell, 2011; Dashwood, 2014).

Because knowledge ecosystem as any complex adaptive system is open, new order emerges in reactive and proactive ways through *endogenous*, or within-the-system, *coevolution* and *exogenous coevolution* that occurs when a system interacts with its environment (Mitleton-Kelly, 2003), thus increasing the *adaptation*. Due to the constant adaptation sudden and unexpected transitions to a radically different form of order may happen (Parsons 2007). It can be explained through the concept of *non-linearity*, or sensitive dependence on internal conditions (Prigogine and Stengers, 1984). This means that being in a network leads to the interdependence of network actors, and then even a single action can affect the fate of the entire system. In order to maintain systemic development, a mutual assistance shall take place - sharing best practices, providing assistance to actors who lack some capabilities. Thus, one of the main indicators of self-organising complex adaptive system is a high level of trust (Carapiet and Harris 2007).

In the knowledge ecosystem, the dynamism of previously mentioned aspects can be analysed through the lenses of knowledge management processes. In this paper, these processes include:

- knowledge generation;
- knowledge sharing;
- knowledge capture or storage in human memories, organisational processes, artefacts and digital systems;
- knowledge utilisation (Zaim, Muhammed and Tarim, 2019).

These processes reflect and are influenced by the primary and secondary parameters. Through the lenses of complexity theory, knowledge sharing is of a vital importance because without interactions self-organisation, which is the central feature of complex adaptive systems, is non-existent (Laihonon, 2006).

Taking into account the parameters of knowledge ecosystem as a complex adaptive system, smartness is understood as a broader concept that an application of digital technologies - smart social system is "a system of communications, when people are ready for their interactions in the environment of their social system but according to the need (especially – to get information and other resources), and are also open to other environments; they are able to envisage the features critical for their environment or their system, to which they quickly and inventively react by adjusting to this environment with adequate decisions as well as using it to attain the goals of their system" (Juceviciene and Jucevicius, 2017). While analysing the dimensions of smart social system, Jucevicius and Liugailaite-Radzvickiene (2013) defined the following dimensions of smartness: *intelligence* or capabilities to compare itself with other social systems and to take particular actions in order to reach the goals; *learning*; *agility* or the ability to respond quickly to the changing circumstances; *networking*; *sustainability*; *knowledge driven*; *innovativeness* and *digitality*. These dimensions reflect previously defined primary and secondary parameters of complex adaptive systems, for example, such as a networking vs. a network of different actors; responsible behaviour, which can be connected to sustainable approach and activities; adaptation, which is also highly connected to intelligence and agility. Thus, by combining the approaches of complexity and smartness of social systems, one should conclude that *knowledge ecosystem is a network of interacting and competing actors, which interact inside the system and with the external environment, by following simple rules of responsible and sustainable behaviour, standards and values, including trust, in order to maintain digital and other types knowledge management processes of knowledge generation, knowledge sharing, knowledge storage and knowledge utilization, which lead to knowledge creation to increase the system's co-evolution, adaptation and innovativeness*.

3. The context of knowledge ecosystem development: case analysis of industrial clusters in Lithuania

The research that was carried out in Lithuania, whose business enterprises still deal with the challenges of cooperation and trust. It included nine industrial clusters that formed naturally on a purpose to cooperate and create innovative products: Cinema cluster, Game industry cluster, Tourism cluster, Machinery cluster, ICT cluster, Wellness cluster, Cluster of medical innovations, Photo electronics cluster and Laser cluster. A multiple case research strategy was adapted (Yin, 2014). The main source of primary data was 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 processes, primary and secondary parameters, as it was mentioned in a previous part of this paper, including knowledge management processes. In overall, the research was based on the four following tasks:

- to identify the actors who initiate and ensure relationships, enabling the formation of self-organising industrial system;
- to reveal the interactions and relationships that allow self-organising industrial system to be viable, adaptive, co-evolving, characterised by learning, trust, and responsible behaviour;
- to reveal the resources necessary for the formation of self-organising industrial system;
- to identify the values and behaviour patterns that support self-organisation and cooperation.

This paper represents the research results, which are directly related to the development of knowledge ecosystem. Based on it, cluster coordinators were asked the following questions: What are relationships with science and educational institutions? How are learning processes *to acquire knowledge* ensured in the cluster? How are communication and collaboration processes *to share knowledge* ensured in the cluster? Is there a scarcity of enthusiasm? If so, how it is solved? Are there competing enterprises in the cluster? If so, what solutions are applied? Are your cluster members more inclined to act individually? How it is being solved?

The amount and variety of questions varied from interview to interview, depending on the previous answers.

Research results have revealed that the cooperation among cluster members and science and educational institutions have intensified after entering the cluster: *"until now, until the formation of that cluster, they did not communicate much with universities"* (Wellness cluster). This cooperation is important because *"The enterprise does not have competence and knowledge"* (Game industry cluster) and *"lacks project expertise in*

certain parts" (Cinema cluster). Thus, as Tourism cluster stated, *"we are always trying to make sure that there is no shortage of science institutions to advise us, because we really recognize that we are not soldiers, if we are in the field alone, we need help, we need academic help"*. Accordingly, science and higher education institutions provide specific knowledge in order to solve issues. The involvement of science and education institutions is significant in developing new projects and implementing scientific research. In such a case, cluster cooperation with universities and other higher educational institutions may include various administrative matters and universities' priority setting to participate in a particular project or not. For example, the coordinator of Cinema cluster stated that *"After the secondary projects started, such as building robots and so on, we called the university, but..."*. One should emphasise that the scheme to attract European Union funding for cluster development formally requires the participation of science and educational institutions. However, it doesn't mean that such relations between cluster and higher education institutions are always formal and artificial – the clusters developed various ways to involve current and new science and education institutions in order to reach cluster goals.

In some cases, these institutions are not only from Lithuania, but from other countries as well. For example, the coordinator of Cluster of medical innovations emphasised the relations between cluster and scientific research institute in Switzerland. High quality international science relationships are formed in the case of high technology industrial clusters too.

Cooperation with educational and science institutions works as a tool to create new study programs and specialisations at the higher education and vocational institutions and thus to reduce the shortage of specialists: *"There is a big shortage of specialists, they need to be trained, so naturally the required specialties were born in universities, such as the Lithuanian Academy of Music and Theatre"* (Cinema cluster). New programs at Lithuanian universities and universities of applied sciences were initiated by Tourism and Game industry cluster too. The latter cluster also shared knowledge about gaming industry to youth through the cluster magazine.

One should emphasise that cluster enterprises in a cluster develop an R&D infrastructure (for example, Game industry cluster, Wellness cluster, Cluster of medical innovations). Industrial clusters also create training systems in order to maintain knowledge acquisition by cluster members. As Game industry cluster coordinator stated, they also created a unique multilayer training system at the cluster level: *"we have know-how, which is transformed into individual training projects with certain training topics; employees are studying according to them and receive certificates"*.

The most common activity to acquire new knowledge is various seminars and training, attended by cluster members. The popular topics are management and leadership (Cinema cluster), marketing, communication psychology, hospitality and foreign languages (Tourism cluster). Wellness cluster mentioned training and seminars on business models, knowledge sharing and personal development. As the coordinator of the latter cluster states, *"enterprises like various seminars, trainings in which they are happy to participate, so maybe some trainings will be more interesting for them, and they will participate and contribute."* Thus, training may work as a tool to increase the activity of members in a cluster.

Training also helps to create social networks: *"Enterprise employees acquire new skills, communicate at the same time, find common connections through communication, work on social capital, which then turns into business contacts and business services or some kind of joint projects between several enterprises"* (Game industry cluster).

It is also emphasised that acquiring knowledge should be continuous: *"you have to chew it every day from different angles, with different tastes"* (Cinema cluster). As it was emphasised by the Cinema cluster coordinator, *"you can only learn from other teachers who do that work, i.e., by working together with them"*.

The coordinator of Tourism cluster also emphasised visiting of cluster members' enterprises in order to learn about their realia: *"we look at their services, where they made some updates"*. Cluster members also visit other clusters, as in the case of a Tourism cluster.

One could conclude that mutual learning about themselves and each other, enhancing trust and creating new ideas, in analysed clusters happens because of the following activities:

- frequent regular company meetings;
- communication in an informal environment;
- project activities;

- participation in publicity events;
- participation in joint training.

However, research results still revealed many challenges, which restrict information and knowledge sharing among the cluster members, such as difficulties in mutual agreement, individualism, competition, and continuous passiveness. Individualism is especially vivid in clusters that represent creative industries. For example, the coordinator of Cinema cluster mentioned the phenomenon of “lonely stars”, who are used to have very strict opinions and don’t hear the others: “the more personalities, the harder it is to manage everything”. Individualism also is related to competition, when “it is not yet possible to distinguish that <...> in the cluster there are one set of rules and outside the cluster there are other rules” (ICT cluster).

However, the biggest challenge to overcome in the most of Lithuanian clusters is the passiveness of a particular amount of cluster members, which are in the list of a cluster only theoretically. Although a temporal passiveness of any cluster member is a normal phenomenon, continuous passiveness is a negative phenomenon in the perspective of knowledge ecosystem development. Often this passiveness is a result of inadequate expectations towards cluster and the attitude of seeking an individual benefit without sharing: “they tend to pursue benefits rather than performance” (Game industry cluster). If this attitude is spreading among the cluster members, the development of knowledge ecosystem is getting restricted because no interactions are happening. In order to increase the development processes, cluster coordinators defined various principles regarding ecosystem development, and those principles reflect the smartness dimension, presented in the previous parts of this paper.

4. Smart principles of knowledge ecosystem development through the perspective of Lithuanian industrial clusters

Jucevičius (2014), while analysing the development of a smart social system, defined the following development principles:

- non-standard approach to development opportunities;
- creation of an ecosystem favourable to creativity, entrepreneurship and innovation;
- formation of community culture.

Research analysis revealed that every research cluster was formed in its unique way: they adapted strategy of experimentation, external agency strategy or strategy of ad hoc colleagues-professionals. While continuing with their activities, strategy of active coordination, coordinated self-organisation or self-organisation was implemented with its individual expressions. These strategies aren’t going to be detailed further in this paper but they are mentioned to confirm the different perspectives towards development that fit the particular reality the most.

Research results revealed that the cluster members and clusters themselves become more innovative – they create more innovative products; thus, they are able to commercialise new knowledge. Clusters became competence centres: “cluster now is a certain base, with some history and with know-how, how to do and develop projects of a similar profile” (Cinema cluster).

Much attention in the clusters is given to the development of community culture. First of all, it is important to emphasise that *the members of cluster individually should develop their positive attitude towards a cluster and activities there*. Individual characteristics in order to contribute more into cluster processes can be defined as follows: enthusiasm; belief in a cluster; working for the benefits of the cluster/ ability to contribute to the cluster’s activities; openness; complementing each other; consulting and helping each other; teamworking; confidence; ability to take benefits of the cluster and long-term orientation.

It is a “consistent, steady, hard work to fulfil the commitments and goals”, making the contribution to the development of the cluster and its processes: “You have to give. You must bring. You must contribute” (coordinator of Cluster of medical innovations). Many of the characteristics are directed outwards - cooperation, negotiation, openness, etc., and this clearly contrasts with individualism. As the coordinator of ICT cluster stated, “everything depends on the person - if there is an interested person in the enterprise, who believes in the idea, and for whom that cooperation, communication is acceptable, everything goes normally”.

Personal efforts to participate in the development of a cluster also depend on a long-term orientation, i.e., realising that a cluster is a long-term phenomenon, where the results and the benefits can emerge only in the long-term period. In turn, “focusing on short-term goals” contributes to non-participation in cluster activities. Although training programs and systems are important to cluster members, it must result in continuous knowledge sharing, creation and adaptation - the members themselves must mature, taking new initiatives themselves and thus setting an example for each other, coordinating various processes among themselves. *Research results revealed that the cluster members who show their personal example of knowledge sharing are of great importance.*

The other principles are as follows:

- setting boundaries between cooperation and competition;
- developing a healthy attitude to competition;
- defining a clear vision, mission, values and goals in the cluster at the beginning of the activities;
- specialisation and differentiation in order to be unique and decrease competition;
- developing of a new joint (innovative) product;
- discussing each issue;
- dialogue;
- frequent regular and positive communication;
- following common principles of consensus and transparency;
- mediating in cooperation processes;
- explaining the importance of cooperation;
- defining realistic expectations that naturally respond to modern business needs;
- explaining meaningfulness of the cluster activities;
- highlighting the benefit of being in a cluster;
- inspiring optimism;
- involvement in working groups reflecting various areas of cluster activity;
- creating projects;
- applying idea generation methods.

A healthy attitude to competition means that everyone can find their niche: “there will be enough room under the sun for everyone” (Cluster of medical innovations). In addition, according to the interview with a representative of Laser cluster, “competition is running together” to achieve a common goal, when the runners - business enterprises – possess different capabilities. Thus, *it is very important for cluster enterprises to define common goals and achieve them* – for example, as the coordinator of the Medical innovation cluster stated: “let's conduct a scientific research together!” A common goal is also a development of a new joint product. This means creating something that no other cluster enterprise has competed / is competing for, and *each enterprise occupies a certain niche in the product development process* based on the competencies it has. In this way, cluster members “trust the cluster more, because they do not need to reveal their competitive advantages” (Wellness cluster). It is also important to emphasise that enterprises belonging to clusters often develop their *specialisation and apply a differentiation strategy*. Consequently, even if they do not participate in the development of innovative products of the cluster, they do not experience significant difficulties due to competition.

In general, setting a clear vision, mission and goals is a significant tool to decrease conflicts and disappointment later. As the coordinator of Machinery cluster stated, “everyone identified that activity, the goal”, and “there are no major disputes, discussions, antagonisms”. Meanwhile, when dealing with various common matters in the cluster, it is important to always *discuss each issue* and follow “both the principles of consensus and transparency” (Machinery cluster). It should not be forgotten that a better mutual agreement depends on knowing each other more and spending time together. Cluster coordinators emphasised the importance of regular frequent communication. In addition, “positive communication is needed” (Cinema cluster). The source of positive communication is informal communication, which allows individuals to learn more about each other and gain trust.

Game industry cluster coordinator said that difficulties in cooperation are more related to “ignorance” or “lack of training”, thus, the following solutions can be distinguished, such as *mediation in cooperation processes* and

clarification of the importance of cooperation, which can also take place in practice - through the organisation of joint events. One of the main *values* that should be embedded into cluster activities, is *unity* (Cinema cluster).

Common reasons for continued distraction from cluster activities include inadequate expectations of the cluster, expecting benefits without putting effort in it, and not seeing the meaning of the cluster. (for example, Cinema cluster, Tourism cluster, Machinery cluster; Cluster of medical innovations): "in theory, everyone imagines that it's very cool, that everything is very easy to do", that "if we become members of the cluster, that's all - <...> someone will help earn money", etc. Seeking benefits with a limited amount or no efforts can be also characteristic of scientific institutions as members of the cluster. The coordinators of both creative industry clusters talk about this: "they usually seek benefits, not activities".

Disappointment with the cluster increases even more in the face of difficulties, and then a phenomenon is observed where "some came very active and enthusiastic at first, but now they are less active and maybe no longer enthusiastic". Thus, *realistic expectations must be defined in the cluster*: it is important to understand that "the cluster cannot move mountains". Research results reveal that the meaning of the cluster is to benefit from the activities through the sharing of mutual burdens. The benefit can be seen through the meaningfulness and purposefulness of the activities carried out in the cluster: "if we organise an event, we know why we are organising it, for what purpose, what lecturers, what benefit". When activities are meaningful and useful, cluster members experience a variety of positive emotions, including joy and pride, and this has a significant impact on enthusiasm, without which "there is no point - you can't do anything you're told."

In some cases, however, it is necessary to *highlight the benefits of the cluster and inspire optimism*. The members of the cluster are encouraged to be proactive and get involved in activities, whether they are business enterprises or scientific institutions. Enterprises can be included in working groups to solve various cluster issues, projects are created, trainings are organised. The most ideal case, when the cluster members themselves set goals, generate their own relevant ideas, and seek their own solutions. This corresponds to the essence of a complex adaptive system - initiatives must come from below and not be imposed.

5. Concluding remarks

Knowledge ecosystem is, in a broad sense, is a self-organising network of actors, interacting on the ground of simple rules and common values and behaviour models with a purpose to maintain knowledge management processes in order to create new knowledge. When adapting the expanded concept of smartness, the development of knowledge ecosystem has a strong emphasis on relationships in the system and with an external environment and is oriented to system's adaptation, sustainability, innovativeness, learning, agility.

A multiple case study of nine industrial clusters in Lithuania revealed the aspects of knowledge ecosystem development. All the clusters developed relationships with science and higher educational institutions for developing projects and R&D, creating new study programs and specialisations in order to deal with the scarcity of specialists. Clusters also developed their R&D infrastructure and training systems for cluster members in order to nurture their technological and soft skills.

One should emphasise that clusters make efforts in adapting a non-standard approach to development opportunities, creating conditions for creativity and innovation and forming a community culture. However, clusters still experience the challenges of competition, passiveness or disagreement, which hinder knowledge sharing and new knowledge creation as a final result. In some cases, various seminars, provided by a cluster, become an attractive activity to be in the cluster, even without getting involved in further activities. Thus, smart development principles

Thus, smart principles to encourage the development of relationships and knowledge ecosystem accordingly are related to the development of specialisation and differentiation, defining clear mission, vision, values (such as values of unity, cooperation, transparency) and goals, defining realistic expectations, highlighting the importance and benefits of cooperation and being in the cluster.

However, the research has some limitations. First of all, it provides a glimpse into overall processes in clusters from the cluster coordinator perspective but doesn't analyse the perspective of cluster members. Thus, further

research may concentrate on the analysis of the relationships between different cluster members in order to analyse knowledge management processes and implementation of smart development principles in more detail.

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