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Smart development of innovation ecosystem

Giedrius Jucevičius[a,]*, Kristina Grumadaitė[b]

[a]*Kaunas University of Technology, Lithuania, giedrius.jucevicius@ktu.lt*
[b]*Kaunas University of Technology, Lithuania, kristina.grumadaite@ktu.lt*

Abstract

In this article, the approach of complexity theory to the development of innovation ecosystem is presented. Innovation ecosystem is understood as a smart system that is explained by the characteristics of complex adaptive systems. Thus its development is based on the mechanisms of management of complex adaptive systems and integrates both top-down and bottom-up approaches towards the development of innovation ecosystems. Smart development of innovation ecosystems relies on pattern formation, sense making, definition of simple rules, change of attractors, tagging, chunking and maintaining disequilibrium, as well as the mobilization of niches.

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1. Introduction

The literature on ‘systems of innovation’ has been largely dominated by the institutional list approaches with emphasis on the structural aspects of the innovation systems (e.g. “triple helix” of government-academia-industry, infrastructure, policy and political environment). Such actor-focused approach laid out by the advocates of regional (RIS) or national innovation systems (NIS) has for long been attractive to the policy makers that seek the clearly defined and, in most cases, linear solutions to the development of innovation system. However, it is of limited value for achieving a truly functioning innovation system because it fails to take into account its complex social dynamics. A gradual switch away from “innovation system” towards the “innovation ecosystem” can be observed in the academic discourse. The key properties of any biological or social ecosystem, such as diversity of actors and their

* Corresponding author. Tel.: NA.
E-mail address: giedrius.jucevičius@ktu.lt

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network ties, co-evolution, self-organization and disequilibrium are increasingly used for describing the innovation "ecosystems". However, the theory of complex adaptive systems is still largely used for the interpretive purposes, but provide little advice (compared to the systems theory underlying much of the research on "systems of innovation") on the development of the innovation ecosystems.

Thus, the aim of this paper is to provide insights into the possible applications of complex adaptive systems theory for the development of innovation ecosystems. The paper rests on an assumption that the development of innovation ecosystems calls for new approach, whereas the institutional and system theories are too static. The complex adaptive systems (CAS) approach may offer some valuable perspectives; however, the studies of management and development of CASs are still in their infancy. The concept of smart development takes into account the complex dynamic nature of the system and is based on promoting the productive self-organization rather than imposing the top-bottom linear solutions.

In the first part, the traditional approaches to the innovation systems, their limitations and the need for complexity-based approach are discussed. Systems theory is contrasted with the complex adaptive systems theory.

In the second part, the main theoretical insights into the development of complex adaptive systems are presented. Finally, in the third part their implications for the development of innovation ecosystems are discussed.

2. Method

In order to define an approach towards smart development of innovation ecosystem, the analysis of scientific literature about complex adaptive systems, their characteristics and management and transition mechanisms was performed.

3. Results

Development of innovation (eco) systems: systems theory vs. complexity theory. Systems theory and system thinking are concerned with defining the ideal future state of the system and trying to close the gap. Such are the conceptual grounds for many of the acclaimed management theories and instruments (e.g. Six Sigma, Balanced Scorecard), including the innovation systems approach. If often relies on a rather simplistic and linear attitude: mixing the right ingredients (inputs) will produce predictable results (outputs). Thus, the innovation systems are often treated as complicated systems (i.e. with diverse actors, yet predictable interactions and equilibrium state) rather than complex systems (i.e. with diverse actors, but with multiple unpredictable interactions and potential for disequilibrium).

Complexity theory has no ambition of predicting the future or defining the "ideal" state of the system - it is more about describing the present and seeing what can be changed. "Get the inputs right and the desired outputs will follow" attitude does not necessarily work (in most cases, it does not) when developing the systems that are complex by their very nature, such as the innovation ecosystems.

It is an ongoing debate to what extent the innovation ecosystems should be regarded as different or rather as supplementary to the traditional "systems of innovation". The system of innovation approach traditionally builds upon the perspective of institutional economics and its system-related research, e.g. business systems, social systems of production, industrial districts or clusters. The innovation ecosystem approach, on the other hand, looks into the very nature of successful innovation systems and emphasizes that system is much more than a sum of its parts. There are too many innovation systems with apparently all the right elements, yet they still fall short of expected outcome. The innovation ecology only partly depends on presence of elements (i.e. talent, firms, institutions, capital), but even more so on their identities, meaning, networking capabilities, culture of trust and pragmatic cooperation. Thus, in this respect, the innovation ecosystem approach is supplementary rather than contradictory to the approach of "systems of innovation" because conventional logics suggests that the elements have to be established before one can talk about their linkages. On the other hand, from the perspective of management, building and developing the institutional "system of innovation" and nurturing the "innovation ecosystem" are two very distinct processes. To use a metaphor, creating a park is very different from raising a rainforest. Planting trees and creating ecology are two different tasks that cannot be successfully achieved with the same mental model. It even brings into question our previous assumption that one can plant the trees before creating the ecological system

because without environmental support no trees can be sustained (yet at the same time they are essential to the emergence of such system). Such discussion may lead us to the situation of a closed feedback loop and the eternal "chicken and egg" dilemma. However, from the management perspective we are still entitled to seek possible solutions to the development of complex systems.

Some answers are possible in this respect.

First, one has to decide what type of innovation system is under consideration. The research on national and regional innovation systems has revealed a variety of innovation systems with varying degrees of relational complexity, nature of inter-actor ties and knowledge involved. For example, many of the traditional approaches to hold true for the institutional innovation systems whose innovative output (i.e. usually the incremental innovations) relies on codified knowledge, strong rules and institutional framework (e.g. Baden-Wuerttemberg in Germany). However, the emergence of entrepreneurial and socially embedded innovation systems is a much more subtle process that can hardly be achieved with the direct policy measures and incentives. This is where creating the right ecological conditions becomes crucial before any start-ups ("trees") are about to emerge.

Second, smart development of complex dynamic non-hierarchical system becomes of key importance. It is not so much about finding the right compositions of elements, but stimulating their relations and interactions in non-linear and non-hierarchical ways. It is not about defining the system and its boundaries, but about facilitating the self-organization of its actors and emergence of the system out of multiple interactions. However, one has to decide what aspects of the development of complex adaptive systems are best applicable for nurturing the innovation ecosystem because one should be cautious when direct drawing analogies between the biological and socio-economic systems.

Innovation ecosystem as a complex adaptive system: managerial implications. The concept of ecosystem has arisen in the sciences of biology and in general means "an interactive system established between living creatures and their environment in which they live" (Tansley, 1935, cited by Krause, Razavi, Moschoyiannis & Marinos, 2009). Innovation ecosystems can be characterized by a combination of top-down and bottom-up initiatives (Schaffers, Komninos & Pallot, 2012) that foster networking and the development of new products and services.

The approach of complexity theory towards innovation ecosystem allows us to understand its development from a different perspective. Innovation ecosystem is viewed then as a dynamic system, characterized by localized interactions among a huge amount and diversity of agents (Cilliers, 1998; Plowman, Solansky, Beck, Baker, Kulkarni & Travis, 2007; Johnson, 2009) – universities, business enterprises, public institutions, society, resources, etc. Their interaction is based on the principle of self-organization (Laihonen, 2006; De Toni, Biotto & Battistella, 2012; Chiles, Meyer & Hench, 2004). It means that responses to environment are emerging from spontaneous bottom-up interaction without a central control. This statement strictly contradicts the widely known top-down approach towards the development of innovation systems. Also, innovation ecosystem as a complex adaptive system cannot be explained in simple input-output processes. Because of a spontaneous and dynamic interaction between agents in the networks, the system gets hardly predictable. Innovation ecosystems balance at the "edge of chaos", where the creativity and innovativeness are at the highest level (Mason, 2007). In such systems, major interventions may fail, while minor changes cause huge outcomes, when the tipping point is being reached and a system moves to another attractor (that is understood as a conditionally predictable dynamic state) or falls down to a dangerous chaotic area without an attractor. Despite this danger, innovation ecosystems are highly adaptive (Uhl-Bien, Marion & McKelvey, 2007; Johnson, 2009; Plowman et al., 2007) and change their behavior to remain vital.

Innovation ecosystems can be called smart systems because of their openness, interaction with the environment, self-organization and emergence, adaptability, tolerance of mistakes and flexibility (see Murthy & Krishnamurthy, 2003). In such case, the smart development of innovation ecosystem should be analyzed from the viewpoint of complexity theory.

Smart approach to the development of social ecosystem: beyond top-down vs. bottom-up dichotomy. Innovation ecosystem, as any other social system is a result of an interaction of various cultural, economical, institutional and technological factors. Thus, the model of social self-organization presented by Fuchs (2002) can be adapted. This model emphasizes three subsystems of social systems – culture, politics and economics and the dynamics of agents, forces, relationships, results of the interaction in and between the subsystems. In order to choose the mechanisms of the development of innovation ecosystem, one should define the main agents, forces, relationships and outcomes resulting from this interaction in every subsystem and between them; then, to identify the weakest parts in all system

and forces, relationships or results having the greatest impact on them. For example, specific values (a type of cultural forces) influence preferences for cooperation or competition; laws (a type of political result) cause or restrict the freedom of creating and doing business (economic result) and that is based on cultural aspects (for example, power distance).

Since the picture of dynamism of existing social ecosystem is (less or more) clear, the mechanisms to repair the systematic problems can be simulated. There is a list of general mechanisms to manage complex adaptive systems:

- Visioning, sense making (Palmberg, 2009; Lichtenstein & Plowman, 2009);
- Pattern formation (analyzing existing system patterns, which are influenced by a history (Cilliers, 1998), and finding out the aspects that could play a role for the development of an ecosystem (Laihonen, 2006);
- Defining simple rules (Palmberg, 2009);
- Changing attractors (values, people, etc.) (Eoyang, 2001, cited by Lehmann, 2011; Palmberg, 2009);
- Tagging, i.e. identifying people, ideas, processes and other aspects that are giving the sense to actions and showing direction to aggregation (Lao et al., 2008; Laihonen, 2006);
- Searching for various change agents with different characteristics (Colliers, 1998; Plowman, et al., 2007; Frej & Ramalingam, 2011);
- Chunking or concentrating on the links and relationships that are vital and removing the links that don't work (Palmberg, 2009);
- Creating and maintaining the disequilibrium state (Palmberg, 2009; Uhl-Bien et al., 2007);
- Recombining resources (Lichtenstein & Plowman, 2009);
- Allowing experimentation and reflection (Palmberg, 2009);
- Allowing and maintaining a feedback (Lichtenstein & Plowman, 2009; Palmberg, 2009).

The need for some or all mechanisms mentioned above depends on a particular situation. For example, it may become apparent that the main problem in a particular part of the system is a lack of understanding what should be done. In such case, a mechanism of visioning or sense making would be appropriate. In other cases the problem may need more complex solutions (for example, changing attractors and pattern formation). In some situations even the sub-mechanisms of particular mechanisms (for example, allowing experimentation and reflection) should be defined.

When a system is very rigid and resistant, a very useful tool is to enable the formation of niches that are new emerging structures provided with resources (Fischer-Kowalski & Rotmans, 2009), where learning occurs and social networks, developing new innovative solutions, are created (Romero-Lankao & Gnatz, 2013). They are built by a small group of newcomers-frontrunners that are capable of creative and strategic thinking (Fischer-Kowalski & Rotmans, 2009). Niches are closely related to grassroots innovations that are innovative networks of activists and organizations producing bottom-up solutions, which respond to the local interests and values (Seyfang &Longhurst, 2013). Niches can be understood as a way of system transformation in radically incremental steps. Those niches don't make any harm to the system in general but create the state of a tension and encourage other members of the system to accept the changes.

It should be also mentioned that so called system holders that are responsible for visioning, setting simple rules, building and maintaining feedback and creating attractors (Palmberg, 2009) may come from governmental, business, societal or any other structures. This system holder can play a role of tag, attractor or catalyst and that is about managing and not controlling.

4. Discussion/Conclusions

Both scientific and applied literature emphasizes the bottom-up approach to the development of innovation system more and more often. However, neither top-down, nor bottom-up approach don't fit to all social, cultural, historical, etc. contexts. The smart development of innovation ecosystem as a smart complex adaptive system integrates both approaches.

It's argued in this paper that smart development of innovation ecosystem is based on a deep understanding of the dynamics of agents, relationships, forces and results in and between cultural, political and economical subsystems of the social system. The repairing of the problematic parts in this system should be done adapting a particular mix of mechanisms and sub-mechanisms of managing complex adaptive systems.

In the future, a more detailed research will be performed on purpose to reveal a clearer dynamics of smart development and generate various sets of mechanisms depending on a particular problem.

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