R&D Ecosystems Success Factors

Ioannis Patias, Vasil Georgiev

Faculty of Mathematics and Informatics
University of Sofia St. Kliment Ohridski"
5 James Bourchier blvd., 1164, Sofia, Bulgaria

patias@fmi.uni-sofia.bg

Abstract. In this paper, the focus is on the R&D ecosystems. The definition provided first by Moore helps identify different viewpoints and R&D ecosystems specifics. Replicating the living and evolving ecosystems, and the involved stakeholders model, and ecosystems evolving model, explaining the two-dimensional value creation are discussed in short. A practical approach to frame the success factors based on the three fundamental properties of evolving systems is introduced. The R&D ecosystem participants, partners, and all the involved stakeholders can be treated as evolving organisms in a living ecosystem, and respectively try to support their ability of reproduction, variation, and competition. The proposed factors can be balanced, prevailing at some point the ability to reproduce, in order to ensure the ability to support new players.

Keywords: R&D Ecosystem, Reproduction, Variation, Competition.

1 Introduction

The ecosystem concept has been developed by different structures starting from companies, and universities to research and development (R&D) institutes and local governments. The major problems to be solved include limitations from formal communications, barriers in knowledge sharing, and collaboration that result in low levels of innovation and development. Ecosystems are relatively new as concept trying to imitate the living biological ones into the business world. They are like centers of research and development, which act as catalysts and help to develop ideas and transform them into successful solutions to the market.

Although the ecosystem concept shares some similarities with older concepts of strategic alliances [1], and business partnerships, joint ventures etc. it still differs in many and significant aspects. First, an ecosystem is not a company or organization that formally works with others in developing new products or services. Any collaboration between the different stakeholders is rather like a long-term relationship, and not like a frame, or agreement. Furthermore, ecosys-

tems main aim is to create innovation-facilitating networks with an, as diversified as possible, range of players in terms of industries, focuses and sizes, where the added value is in the network itself. Successful ecosystem management includes cultivating the diversity of the stakeholders, supporting its density and autonomy and keeping those stakeholders in central position. No ecosystem can develop unless there is intensive mobility of knowledge.

The factors that can help in the success of building and managing ecosystems will be investigated. The focus will be on the generation of opportunities and the used technology and the way to become big in very short time. The innovation agenda must be strategically aligned with the expected outcomes, and have as highest priority the commercialization [2] of the innovation ideas within the shortest possible time. The management structure should define clear priorities right from the beginning. Ecosystems first priority should be building the commercialization competencies, rather than the technology aspect. The success factors identified for the ecosystems include the idea of always maintain a healthy and close relationship with the university as the core organization, but try to build an extended, diverse and balanced range of competencies [3] diversified to cover ecosystem's needs depending on the concrete case.

2 Ecosystems

Let us first provide a definition of the term ecosystem referring to the business. James F. Moore was the first to use this term by applying biological concepts to the world of business in 1993 [4]. His idea was to apply the principles of evolving living systems in business ecosystems.

According to the definition for a business ecosystem provided by Moore it is, an economic community supported by a foundation of interacting organizations and individuals, the organisms of the business world. This economic community produces goods and services of value to customers, who are also members of the ecosystem.

As was recently proved for once again under the COVID-19 pandemic, the faster and most effectively evolving businesses, making decisions based on evidence [5], especially regarding medical matters are the ones that succeed. However, no evolution in living systems occurs in vacuum, and this is true for the innovative business evolution. All necessary building blocks must be available. Meaning, all required resources must be attracted, including capital, the R&D community, partners, suppliers, and customers, technology and platforms, and the regulatory bodies.

In practice, what we realized was that the pandemic did not initiate, but accelerated the migration of the consumers to digital environment. Consumers from all ages, and all backgrounds went online for a wide range of services and prod-

ucts. What we have seen was communication platforms, and offering channels proved to be reliable for decades went down for less than months.

COVID-19 increased also an existing trend where traditional industries and their representatives tried to create their own, or enter in other digital ecosystems. Tech companies supported by their platforms, launched most of those ecosystems that are constructed to offer integrated services. They control customer interfaces and control points such as search, advertising, and messaging.

The market understands this power. Most of the companies with the world's highest market capitalizations are tech companies that generate much of their revenue from the digital ecosystems they created [6].

We need to describe the interrelationships among different stakeholders and ingredients [7, 13, 14] for the development of an R&D information technology (IT) ecosystem, in order to try to identify its success factors.

To group the different stakeholders and ingredients we can use the following structure (Fig. 1):

- funds, financial instruments, and capitals,
- researchers, scientists, and academics, together with their institutions, and other talents and key HR, and the business, as large and small companies,
- providers of technology platforms, data and other infrastructures,
- regulatory and legal environments, and
- users and applications, IT customers as private consumers, business clients, and the governmental sector, to define the different levels from basic research, through applied research, and advanced concept, up to product development,

All these views at the end should be combined in a way that will allow the development IT products and services that contribute for the economic wealth of the respective city, region, and country, create jobs, and serve the society as a whole. However, the successful combination of those views depends on factors, which all the stakeholders should be familiar.

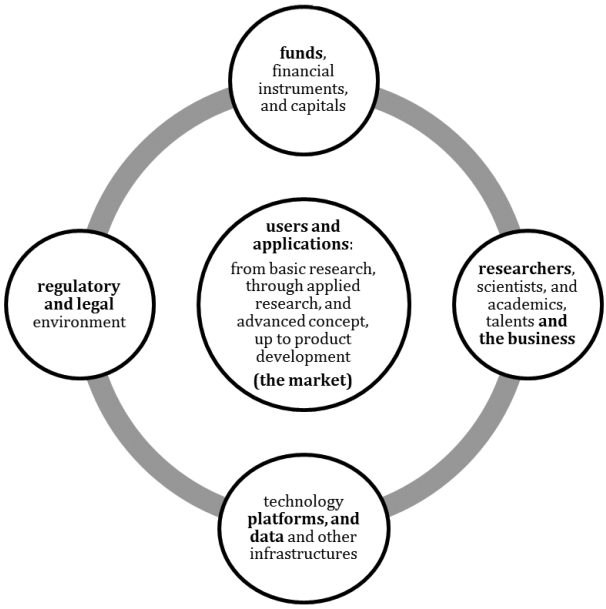

Fig. 1. R&D ecosystem stakeholders, and ingredients.

Once the necessary building blocks are available, we need to consider the process of evolution, like in living systems. In living ecosystems, there are three basic principles, which are common to evolving systems [8]. The three fundamental properties of evolving systems are the ability of reproduction, variation, and competition (Fig. 2).

First, having the ability to replicate or reproduce each species, or different kind that will appear for the first time will be able to continue his kind's life after the concrete individuals degrade. Those kinds of organisms will survive and be represented in the ecosystem - even after the lifetime of each concrete representative, which after all can be shorter. Therefore, it is not important the concrete individual representative to survive. Important is the species and different kinds to replicate or reproduce and thus to survive, no matter how short the individual's lifetime is.

Second is the property of variation, to ensure that the system reproduced undergoes changes. This property ensures that evolution can occur. Otherwise, if the ecosystem replicates always the same next generation as the current generation, and its parent generation, there will be no evolution.

Last is the ability of the ecosystem organisms to compete. The reproduced organisms in the ecosystem compete with one another for gaining the available resources. It is a property that allows the occurrence of the evolution by natural selection. The process starts with the property of variation, which will allow

the production of different populations. Out of those different populations, there will be, even by chance, variant offspring better suited (than their parents) will for survival and reproduction under the prevailing concrete conditions. This is the prevailing conditions selective pressure, which gives advantage to different populations. Therefore, those populations, which are best able to survive and to reproduce themselves, will increase in relative concentration. Thus, we have new players, which are better and by gaining, more of the resources are able to reproduce, develop, and occupy territory in terms of relative concentration.

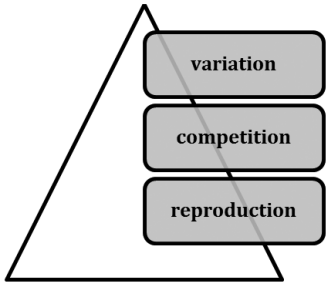

Fig. 2. The three fundamental properties of evolving systems.

3 Ecosystems characteristics and KPIs

Here we should underline the difference between the many kinds of networks, like cooperation networks, strategic partnerships, and alliances, joint ventures, or virtual organizations, and ecosystems. The first group of different kinds of networks is focused on the corporate terminology and attitude towards organizational frameworks and management structures. On the other hand, the ecosystem approach, as defined above with the parallelism with the living biological systems, examines the business development and the innovation commercialization as the living processes in evolving systems. As they evolve with their characteristics and ethical aspects [9].

The logic of corporate strategy is changed by the strategic logic of permanent change. Thus, we have a living and evolving system of business communities, moving, and changing all the time. It starts from generating intellectual property [10] and goes through establishing new businesses to new products commissioning, and jobs creation. Those representatives, the players that will have the ability to adapt will survive and gain recognition.

Every business ecosystem develops in four distinct stages: birth, expansion, leadership, and self-renewal—or, if not self-renewal, death [11]. However, in practice those stages of the evolution may appear in a more fuzzy way, and even overlap. The managerial team should clarify the picture and resolve any

problems. Such issues that appear in many different industries are related to the process of mixing competitive and cooperative business strategies.

An evolving model, which explains how ecosystems work, is two dimensional, which describes the creation of value. At the horizontal dimension, the idea is to allow participants to consolidate a range of customers, often across sectors. The vertical dimension refers to how ecosystem players cover different aspects of the customer needs at various levels (fig. 3). The business models cover both B2C and B2B, but they should avoid concentrate in one point everything they need and try to build everything in-house. It is rather the management team again that should set up incentive schemas that will attract more players and expand the frame of the ecosystem to include many more industries and players. It is namely such moves that help the ecosystem expand and play its real role in creating value for all the participants, and cover a wider and wider range of participants.

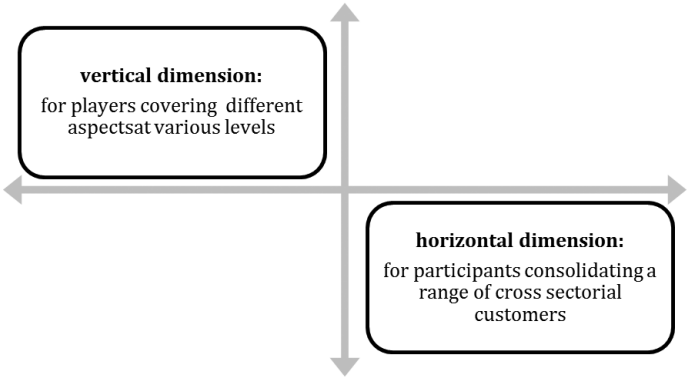

Fig. 3. Ecosystem evolving model, explaining the two-dimensional value creation.

Successful participation in ecosystem means to change the attitude towards the client. Extension of the offering, expansion of the sectors, and avoidance of any such limitations is a key approach for traditional firms, and organizations.

The benefit comes when the offering goes above the traditional range and includes products and services that could not be created by individual firms, but rather as a co-product or combined service of the ecosystem. These relationships along the ecosystem's value chain [12] create a client or customer-centric business model, based on a unified value proposition where the end-user enjoys the end-to-end experience of a wide range, combined products and services.

Big technology vendors and regulatory bodies also participate with a key role in the schema. Tech vendors support the growth by strategic decisions in the direction of offering the necessary platforms to the ecosystems and their players. Bright examples could come from the provision of different technologies and tools to manage wide range of databases and use advanced AI, as instruments for exam-

ple to help better understand consumer's needs, and respectively align and improve ecosystems' offering. The regulatory bodies can also support the ecosystems development, with their institutional role, and promote more economy benefits.

Closing this section, we will try to identify the most appropriate key performance indicators (KPIs). Based on the provided definition of ecosystem, we can now define some KPIs for a healthy R&D ecosystem (Fig. 4). The KPIs should include the:

- generated intellectual property, both in terms of quality and quantity,
- established businesses, in terms of economic value,
- products which came on the market, commissioned end products, in terms goods and services diversification, and
- created jobs, both in terms of quality and quantity.

Below the KPIs, which are directly related with the work product of the ecosystem, there should also be used some KPIs to evaluate its overall performance. Such KPIs are wider in terms of geography, sectors, and timeframe, and cover more strategic characteristics of the ecosystem:

- adaptability, in terms of mechanisms and procedures to respond to changing conditions, and
- recognition, in terms of the level to collaborate with and compete against other ecosystems (local, national, regional, global).

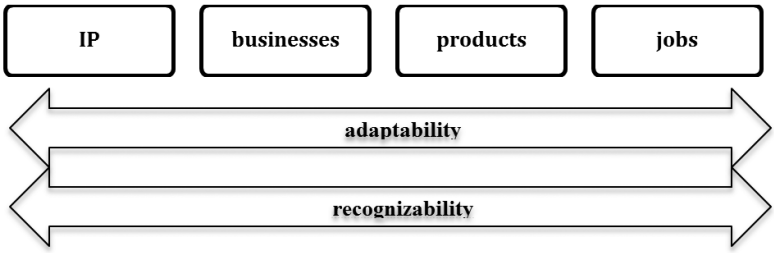

Fig. 4. Ecosystems KPIs.

Attention should be paid and make sure that the number of KPIs is kept as small as possible. A short and to the point schema of KPIs help the team to concentrate on the job to be done, and not on the complicated reporting mechanism.

4 R&D ecosystem success factors

In this section, the empirical findings related to discussions, interviews, and projects experience will be presented. No strict boundaries between the R&D ecosystem stakeholders presented in section 2 (Fig. 1) and the proposed success factors were identified. We also could not determine any grouping criteria for the

success factors and neither the ecosystems evolving model, explaining the two-dimensional value creation (Fig. 3), nor the ecosystems KPIs (Fig. 4). Thus, we framed the success factors for three fundamental properties of evolving systems (Fig. 2).

Thinking of the ecosystem participants, partners, and all the involved stakeholders as evolving organisms in a living ecosystem we need to support those three fundamental properties of evolving systems, namely the ability of reproduction, variation, and competition. We tried to balance, prevailing at some point the ability to reproduce. This will ensure the ability to replicate the necessary species, and different kinds. We make sure that partners that will appear for the first time will be able to continue their kind's life after they degrade, as concrete individuals representing their kind. Following are presented the success factors grouped per supporting fundamental property of evolving systems.

4.1 Success factors supporting reproduction

First, we need permanent inflow of new participants, partners, ideas, knowledge etc. Therefore, we need to remove any limits and barriers for new player's entrance, and participation, and help to increase the number of participants in projects and initiatives. It is important to put the focus on the coordination activities for the participants and partners, and be prepared and flexible to exploit any unexpected opportunities.

The longer the participants stay in the ecosystem, the more the effect increases. It is thus important to promote active partnership, and participation in the long-term, as only longer interactions and collaboration in time create mutual win-win opportunities. We should further support the participation by using modern planning tools aligned with any uncertainties, and limitations, and use during all project phases' flexible coordination tools.

The created benefit of the ecosystem increases when the participants cooperate and build partnerships. This is why we need to cultivate potential synergies development culture, by promoting synergies between diversified participants, sectors, and industries, by identifying any new application of existing technology or knowledge in other industry than the current core industry, and supporting cross-sectorial exploitation and collaboration opportunities. This is why we should facilitate even small inventions, as they provide large effect when they are effective combined, examine in detail the possibilities of turning technology into profitable opportunities, and facilitate always project funding and laying the foundations for future collaborations.

Help all kinds of interaction processes and organize presentations of potential partners ideas and technologies, and facilitate collaboration, with motivating potential partners to participate in collaborative projects and building future op-

portunities, and facilitating know how and knowledge transfer and creating common standards and understandings among participants.

Finally yet importantly for the reproduction priority, is to formalize processes for strategic partners selection, and partnerships building cultivate the synergy effect among ecosystem participants and facilitate collaboration with new ones, and support participants and partners during their efforts to determine their position in the innovation value chain.

4.2 Success factors supporting variation

In living ecosystems, variation ensures that the system reproduced undergoes changes. This property is also important for R&D ecosystems, to ensure that evolution can occur. Otherwise, we will always reproduce replicates of the same generation as the current one. For the specific case of R&D ecosystems, this can be translated to develop knowledge, expertise, capacities and ideas within the ecosystem, and be open for new technologies. These technologies can make us flexible in finding new solutions and applications, support strong knowledge of the subject matter that makes easy to understand the required resources and competences, and attract the appropriate players to contribute. They can facilitate further subject matter knowledge that can also help in estimating the necessary communication channels and the fair valuation of any expertise and capacities required, and well-described and document knowledge as it can be used for further exploitation in terms of basis for both further development, but also collaborations initiation.

However, in order to develop knowledge in R&D ecosystems we need to first formulate a clear research agenda. This can be achieved by setting clear and achievable goals for technologies, and exploitation focus, supporting potential synergies for applications and solutions development both inside the current industry and outside of it. Furthermore, identifying potential application of existing solutions in new industries, stimulating any inspiration for new projects based on existing solutions, and promoting the combination of diversified knowledge and knowhow from different industries, and companies to maximize cooperation effects.

To accelerate the process of knowledge development it is important to facilitate the use of roadmaps, and facilitate the development of technologies clusters based on common characteristics like new solutions, market opportunities, and develop technology-based paths to new markets.

The property of variation requires helping develop a diversified range of different kinds of participants. This is the reason to stimulate both financial and strategic goals, and objectives, and distinguish the financial and strategic goals, and objectives to the partners and participants and set clear focus on both. Fur-

ther to combine market's goals and objectives with research ones to resolve the high uncertainties of the research and development projects. This means a focus on additional management efforts in order to find a balance between exploring business opportunities and investigating research agendas, and manage the difficulties in determining the required investment versus the expected profits, by combining information from participants already in the market and respectively align the goals and objectives.

4.3 Success factors supporting competition

Last but the same important is the ability of the ecosystem organisms to compete. New companies with new offering, new products and services will compete with one another for gaining the available resources. This will be further supported by the market powers and move ahead allowing the occurrence of the evolution, not by natural selection, but by market mechanisms-based selection. To stimulate the competition we need to categorize the different goals for different players, and align the overall strategy of the different players, companies, institutes etc. with the used technologies, and platforms, unify results interpretation for the different partners and participants, and promote our views for the expected pilot results.

Support this differentiation by setting clear and achievable goals with indicative but expressive milestones, in order to support a process of identifying the coming requirements for activities and priorities, identify and present to all participants the potential risks the earliest possible, and define and align common understandings for risk levels, their perspectives and views with all participants.

All interactions can bring benefit, which may be not seen now. Thus, it is necessary to document all interactions between participants and partners necessary. It also use interactions documentation to focus on common interests, and limit any misunderstandings, formalize the process of documenting all interactions that can help avoid any difficulties in transfer of lessons learned from previous projects, and facilitate the knowledge management processes that can support the future development of valuable ideas captured during such interactions.

Last but also necessary is to support responsibility, and ownership of the different projects, and initiatives, and define early in the project-planning phase each partner and participant's role and identify their strengths and weaknesses, and avoid conflicts regarding the initiatives results and their exploitation.

5 Conclusions

In this paper, the term of ecosystem as defined by Moore was discussed under different viewpoints aiming to apply it in the specific case of R&D ecosystems. Starting with the initial definition, which is replicating the living and evolving ecosystems, it was further widened to cover the needs of the R&D ecosystems,

with the involved stakeholders, and their evolving model, explaining the two-dimensional value creation. We found to be practical the approach of framing the success factors based on the three fundamental properties of evolving systems. The R&D ecosystem participants, partners, and all the involved stakeholders can be treated as evolving organisms in a living ecosystem, and support the three fundamental properties of evolving systems, namely the ability of reproduction, variation, and competition. We balance the proposed factors, prevailing at some point the ability to reproduce, in order to ensure the ability to replicate different players.

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References

1. Estanol, A.B., Meloso, D. & Seldeslachts J. (2012). Success and Failure in Strategic Alliances: Theory and Experimental Evidence. Experimental Economics VII. Available at: https://www.semanticscholar.org/paper/Success-and-Failure-in-Strategic-Alliances%3A-Theory-Banal-Esta%C3%B1ol-Meloso/b9cf58cd71c4533c44527c74ce94609f1a2cba2e, accessed January 2021.
2. Lichtenthaler, U. (2005). External commercialization of knowledge: review and research agenda. International Journal of Management Reviews, Vol. 7, pp.231–255. Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-2370.2005.00115.x/full, accessed January 2021.
3. Vodenitcharova A., Leventi N., Popova K. (2019). Students attitude towards medical ethics education, Vol 7 (2019): CBU International Conference Proceedings 2019, https://ojs.journals.cz/index.php/CBUIC/article/view/1466/1991, also at: https://doi.org/10.12955/cbup.v7.1466 accessed January 2021.
4. Moore J. (1996). Predators and Prey: A New Ecology of Competition. Harvard Business Review 71(3):75-86, May/June 1993. Also available at: https://hbr.org/1993/05/predators-and-prey-a-new-ecology-of-competition, accessed January 2021.
5. Leventi N., Yanakieva A. (2018). Pilot survey of the medical professionals in Bulgaria on integration of EBM training in medical education curriculum, Vol 6 (2018): CBU International Conference Proceedings 2018, DOI: https://doi.org/10.12955/cbup.v6.1272, also at: https://ojs.journals.cz/index.php/CBUIC/article/view/1272, accessed January 2021.
6. Chung V., Dietz M., Rab I., and Townsend Z. (2020). Ecosystem 2.0: Climbing to the next level, McKinsey Quarterly, September 2020, available at: https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/ecosystem-2-point-0-climbing-to-the-next-level#, accessed January 2021.
7. Benhamou, E., et al. (2009). ENHAMOUComputer Science and Telecommunications Board, Division on Engineering and Physical Sciences, Assessing the Impacts of Changes in the Information Technology R&D Ecosystem: Retaining Leadership in an Increasingly Global Environ-

ment, ISBN: ISBN-13: 978-0-309-11882-8; ISBN-10: 0-309-11882-4, booklet available at: http://lazowska.cs.washington.edu/CSTB.Eco.pdf, accessed January 2021.
8. Berg J., Tymoczko J., Stryer L. (2002). Biochemistry 5th edition, Section 2.2 Evolution Requires Reproduction, Variation, and Selective Pressure, New York: W H Freeman; 2002. Also available at: https://www.ncbi.nlm.nih.gov/books/NBK22508/, accessed January 2021.
9. Leventi, N., Vodenitcharova, A., & Popova, K. (2020). Ethical aspects of the use of innovative information technologies in clinical trials. Proceedings of CBU in Medicine and Pharmacy, 1, 66-70. https://doi.org/10.12955/pmp.v1.100 accessed January 2021.
10. Grindley, P. & Teece, D. (1997). Managing intellectual capital: licensing and cross-licensing in semiconductors and electronics. California Management Review, Vol. 39, No. 2, p.9. Also available at: https://www.semanticscholar.org/paper/Managing-Intellectual-Capital%3A-Licensing-and-in-and-Grindley-Teece/5434555920e2bbc888d0b6a1e97705e0eed0aa44, accessed January 2021.
11. Moore J. (1996). The Four Stages of a Business: Life Cycle Lessons from Nature, Leadership, July 1, 1996 / Third Quarter 1996 / Issue 4. Also available at: https://www.strategy-business.com/article/17719?gko=6f525, accessed January 2021.
12. Harrison, K. (2019). What is a value chain analysis? Business news daily. Available at: http://www.businessnewsdaily.com/5678-value-chain-analysis.html, accessed January 2021.
13. Papapostolu T. (2019). ADL: An Architecture Description Language for MicroServices, Proceedings of the 1st International Conference on Human Interaction and Emerging Technologies (IHIET-2019), pp. 885-889, https://link.springer.com/chapter/10.1007/978-3-030-25629-6_138.
14. Stanev I., Koleva M. (2019). Why the standard methods, 5GL, common platforms and reusable components are the four pillars of the new computational paradigm Programming without programmers, International Journal of Education and Information Technologies, issue:13, https://www.naun.org/main/NAUN/educationinformation/2019/a142008-aan.pdf, pages: 49-58, ISSN (online): 2074-1316.