

Cross-Sectoral Digital Platform and Innovation Ecosystem Development

Subjects: Business | Economics | Regional & Urban Planning

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A cross-sectoral ecosystem is considered to be a mechanism for the cross-sectoral interaction of an unlimited number of actors of a certain technological sector of the economy in a platform-based single digital circuit that provides digital tools and services to ensure accelerated growth and reduce costs through synergy from multilateral interaction based on common rules and principles of self-government, digital transparency, networking, and equality for all participants.

Keywords: innovation ecosystem ; sustainability ; self-organization ; cross-sectoral platform ; technology platform

1. Introduction

Currently, the concept of an innovation ecosystem is gaining great popularity among market participants and researchers worldwide, which suggests a new organizational and economic model of interaction between participants in economic activity ^{[1][2][3][4]}.

The concept of ecosystems has found application in science, business, and politics. The term “business ecosystem” was originally used and introduced into management science terminology by James F. Moore ^[5]. He defined “business ecosystem” as “an economic community supported by a foundation of interacting organizations and individuals—the organisms of the business world” ^[6]. Several years later, a number of authors ^{[7][8][9]} gave rise to a real research boom, having significantly expanded and enriched the concept of Moore.

The ecosystem model is based on an evolutionary approach that assumes flexibility, dynamism, and adaptability instead of strict determinancy. Indeed, nowadays, companies that strive to develop innovatively and be cost-effective are increasingly dependent on other organizations and businesses in their environment. It is the ecosystem as an organizational and economic model that most appropriately fits this requirement. An ecosystem can be viewed as “a set of actors with varying degrees of multi-lateral, non-generic complementarities that are not fully hierarchically controlled” (^[10], p. 2264). Kapoor ^[11], for instance, views an ecosystem as “a set of actors that contribute to the focal offer’s user value proposition”.

Subsequently, the concept of an ecosystem has become an attractive basis for reasoning various system designs, which has influenced the creation of many research directions in this area. In particular, they include ecosystems of entrepreneurship, knowledge, business, innovation, digital platforms, etc. ^{[12][13][14][15][16][17][18][19]}. An ecosystem is focused on the interaction of actors, system infrastructure, and its underlying processes. This interaction comes from more traditional concepts of clusters, industrial areas, and regional innovation systems ^{[20][21][22]}.

According to Zhao and Zeng ^[23], an innovation ecosystem can be seen as a self-organized evolution system that is associated with environment dynamically. It consists of members that evolve together, including firms; consumers; markets; and the natural, social, and economic environments ^[24]. It promotes the co-evolution of innovation groups and innovation environment by connecting and transmitting material flow, energy flow, and information flow ^[25]. It is more dynamic and evolutionary than an innovation system. Adner and Kapoor ^[26] noted that technology substitution is not merely the competition between two technologies. It is the competition between the two technology ecosystems as well. Components and complements bring challenges to the emergence of a new technology ecosystem ^[27]. They also provide opportunities for extending old technology ecosystems. When a technology is seen as part of a system, the value that the technology can bring to its users depends on the technology itself as well as interaction between the technology and other system elements, including technological elements and social-economic factors ^{[27][28]}.

Historically, the ecosystem approach to management in Russia has replaced the rigid vertical hierarchical approach that was attempted to be implemented in practice some decades ago. Then there was an interest in infrastructure projects,

and ultimately the attention of researchers focused on ecosystems—network structures with nodes (centers, hubs) equal in strength and power. Competition is completely absent, and symbiosis of all participants prevails in such ecosystems, being ideal structures. Nowadays, this approach has become dominant in the formation of new management models for innovation processes.

It should be noted that 15 years ago, Ludwig von Bertalanffy described systems theory, revealing the concept of an open, complex, self-organizing, self-regulating, and self-developing system ^[29]. Synergetics of interdisciplinary industries can be the key to solving problems of entrepreneurial activity. Synergy resulting from the joint action of many subsystems provides a transition to a new qualitative level of development of the system as a whole ^[30].

Extensive digitalization of the economy leads to the emergence of novel forms of cooperation between enterprises, and complexity of the existing forms of business organization at all levels ^[31]. In these conditions, the phenomenon of cross-sectoral interaction, that is, interaction between actors from various sectors of the economy, based on the creation of new business models and carried out through end-to-end digital processes in a single information space in accordance with the principles of decentralization and digital transparency, has been manifested ^{[31][32][33]}.

To organize cross-sectoral interaction, appropriate mechanisms implemented according to the ecosystem principle using platform technologies are required.

Over the past few years, the process of transition to digital channels has been observed all over the world, and the ongoing transformations are radically transforming the economy. Now, cross-sectoral digital platforms play a key role in accelerating access to knowledge, economic growth and job creation, equality and participation of different groups, institutional accountability, efficiency of science, and new opportunities for innovation at any economic level. In the absence of resources to meet the sustainable development goals (SDGs), organizations will need to collaborate to make a measurable impact on the lives of people and on the planet. Cross-sectoral digital platforms contribute to the fulfilment of most sustainable development goals because they are a critical cross-sectoral and cross-cutting issue in addition to being an underlying infrastructure or technology for specific development sectors.

As noted above, the emergence of new industries at the intersection of technologies, and new technology markets at the intersection of industries, does not allow one to explicitly identify them as a particular complex, industry, or a sector. The emergence of new forms of business organization, being often hybrid, is an inevitable process caused by progress.

A technology platform is a communication tool aimed at enhancing efforts to create promising commercial technologies and new products and services; attract additional resources for research and development based on the participation of all stakeholders (business, science, government, civil society); and improve regulatory framework in the fields of scientific, technological, and innovative development ^[34].

However, in Russia, technological platforms have not proven themselves to be an effective mechanism for the development of new technologies. This was partly because of offline interaction among platform participants carried out within associations in the absence of modern organizational and economic instruments for the development of innovations, and was directive in nature, implying the availability of budgetary funding. Participation in technology platforms was often formal and did not provide practical benefits for its participants ^[35].

It is well known that high-tech industry is the basis of the country's innovative development, affecting the interests of a large number of stakeholders, including manufacturing enterprises, the state, investors, contractors and suppliers, service companies, research and educational organizations, and consumers.

An innovation ecosystem of high-tech industries is an organizational model for interaction of high-tech industry enterprises, research organizations, small innovative enterprises, and educational institutions, as well as development institutions and regulatory bodies in a single digital circuit in order to facilitate the development and production of high-tech products ^[36].

The digital platform of the cross-sectoral ecosystem in the context of influencing the development of innovation ecosystems provides seamless integration of measures to support innovative projects, synchronization of scientific and technological progress of several industries, and more effective interaction of all actors of the innovation ecosystem, creating a synergistic effect from such interaction.

The socio-economic effect of the creation of ecosystems is as follows:

- Ensuring the growth of shareholder and consumer value of companies. The synergy of cross-industry interaction allows companies to enter new markets with the lowest costs and time costs, ensuring maximum consumer coverage, including at the expense of other ecosystem participants.
- Reduction of transaction costs. Digital transformation allows one to intensify business processes, optimize the management structure. By sharing resources, logistics costs are reduced, production flexibility is increased, and business cycles are accelerated.
- Intensification of innovation. The ecosystem's tools and services provide access to technology, and financial and human resources; protect the results of intellectual activity; and allow for the use of digital systems for managing innovative projects and R&D. Accelerated testing and piloting of R&D results in an ecosystem in which subsequent commercialization takes place.
- Accessibility to new markets. The ecosystem creates new markets and provides access to them for small and medium-sized businesses by integrating large companies into supply chains and reducing transaction costs. Provides administrative, consulting, marketing, and financial support to export companies.
- Reducing corruption risks. The principle of digital transparency increases the coordination of economic relations between the entities of the ecosystem, ensures the traceability and transparency of operations, and allows one to quickly eliminate legal and regulatory barriers that create corruption precedents.

At the same time, a digital ecosystem is a virtual platform that is usually based on an IT platform, where interaction between participants is carried out in business-to-business (B2B), business-to-consumer (B2C), business-to-government (B2G), and consumer-to-government (C2G) formats. Digital ecosystems provide interaction between government, business, and consumer sectors of the economy.

As an example of digital ecosystem, consider the concept of collaborative economy. The collaborative economy, sometimes called the sharing economy, covers a great variety of sectors and is rapidly emerging across Russia. Digital sharing platform is one of the circular economy business models and is aimed at increasing the intensity of existing products use through their rental or sharing. Since marketing offers use rather than ownership of goods, the digital sharing platform contributes to reducing resource flows ^{[37][38]}. Another interesting aspect is that, although the closest groups of individuals have had shared objects and life experiences since the beginning of humanity, in recent years, the development of new technologies and the growth of digital platforms have led to an exponential increase in relationships of exchange between people ^[38]. Many people have already used or are aware of collaborative economy services, which range from sharing houses and car journeys, to domestic services.

Currently, innovation ecosystems are being transformed into digital ecosystems, providing seamless integration of measures to support innovative projects, and more effective interaction among ecosystem actors.

Innovation and industrial ecosystems ^{[1][2]}, being transformed into digital ecosystems, do not fully provide coverage of all participants, from scientists to industrial entrepreneurs, in creating high-tech products. This is due to disunity of actors of these ecosystems, duplication of functions, lack of subject focus, and strategic goal-setting of ecosystem functioning.

It is necessary to create an ecosystem that will ensure synchronization of scientific and technological progress of several sectors of the economy and maximize the efficiency of synergistic effect from the interaction of ecosystem actors.

2. Cross-Sectoral Technology Platform as a Tool for Self-Organization of Actors: Towards the Creation of a Cross-Industry Ecosystem

Cross-sectoral ecosystems are created under the influence of industrial digital transformation and are planned to be the most effective organizational and economic unit of network interaction in the future ^[39].

An idea of cross-sectoral ecosystems implies the interaction of its participants in a single information system according to the standards and principles specified by the ecosystem for all participants. The ecosystem should ensure interaction among the participants and provide them with services and various organizational and economic tools to enable economic activity. The nature of the paradigm of digitalization of the economy is to implement an advanced mechanism for a cross-sectoral ecosystem for the development of new high-tech industries based on a digital platform.

It is digital platforms that usually become a spontaneous basis for the formation of ecosystems since companies attract new users at the lowest costs through such platforms and form the added value of the product together with all platform participants, including consumers.

The architecture of a digital platform is developed depending on the intended purpose thereof. It consists of the platform operator being its management body; the environment for interaction between participants—suppliers and consumers, developers, regulatory, and supervisory authorities; IT services and applied tools; infrastructure—information processing facilities; and data sources ^[40].

Actually, there are many types of digital platforms, and the typification proposed above covers their nomenclature, taking into account the technological features of the end-to-end digital technologies used therein: Big Data, neurotechnologies and artificial intelligence, new production technologies, distributed ledger systems, quantum technologies, industrial internet, wireless communications, and robotics.

A digital platform of cross-sectoral ecosystem is a global information platform that provides network interaction among subjects of various sectors in the economy within the ecosystem, the generation of innovative business models, the launch of end-to-end digital processes at the intersections of traditional industries, and the provision of organizational and economic tools and services to its participants.

Technologically, a digital platform of cross-sectoral ecosystem is a secure information system for data accumulation, analysis, and management that ensures the interaction of participants and provides platform participants with services and tools for conducting business activities.

There are different types of platforms depending on their functional characteristics. **Table 1** provides the authors' analysis of the functionality of various types of platforms for compliance with the purpose of the digital platform of cross-sectoral ecosystem. The analysis has shown that such a platform can combine almost all types of platforms presented in **Table 1** in terms of functionality.

Table 1. Types of digital platforms by functional characteristics. Source: own elaboration.

Types of Platforms	Functionality	Compliance with the Purpose of the Digital Platform of Cross-Sectoral Ecosystem
Technological	Availability of IT resources and end-to-end digital technologies for the development of applied software and services	They can be an integral part of the platform, expanding its practical significance for software developers and ensuring its technological self-sufficiency
Sectoral	Interaction between participants in the same industry or market	They are fully included in the architecture of the platform and can be represented as the base platform
Functional	Availability of specialized software (ready-made solutions) for ultimate consumers	They should be included in the platform as one of the services
Infrastructural	Access to digital infrastructure and development tools	They can be used to solve practical problems in the development of the platform
Corporate	Digitalization of management processes and interaction of economic entities	They should be included in the platform as one of the services
Information	Information access	They should be included in the platform as one of the services
Marketplaces	Access to consumers, ensuring engagement of the parties	One of the important elements of the platform to be implemented as a service

The digital platform of cross-sectoral ecosystem allows one to complete the system components in the process of functioning. The platform architecture allows various industry companies to perform joint activities in the absence of organizational hierarchy elements in the ecosystem on the principles of equality and self-regulation. In this context, cross-sectoral ecosystem based on a digital platform will be a mechanism for strategic development of new high-tech industries.

According to the previous research ^[41], the digital platform of cross-sectoral ecosystem has a number of key features:

- the platform operates on the basis of the principles of digital transparency and reliability of information—organizations authorized for control and monitoring purposes must have access and observe all chains of cooperation links, transactions, and contractual relationships of ecosystem entities;
- the broadest coverage of all possible participants in target industries: federal and regional authorities, regulators, industry associations, industrial enterprises, service companies, research and educational organizations, financial sector, development institutions, small innovative enterprises, and ultimate consumers;
- the ability to integrate third-party platforms: state information systems, platforms of development institutions, regulators, banks, etc.

The digital platform is a tool to create cross-sectoral ecosystems for the development of new industrial sectors and for organizing cross-sectoral interaction among participants therein ^[42].

The socio-economic effect of ecosystem creation is as follows:

- Growth of shareholder and consumer value of companies. The synergy of cross-sectoral interaction allows companies to enter new markets with the lowest costs and time costs, ensuring maximum consumer coverage, including at the expense of other ecosystem participants.
- Decrease in transaction costs. Digital transformation allows intensifying business processes and optimizing the management structure. By resource sharing, logistics costs are reduced, production flexibility is increased, and business cycles are accelerated.
- Intensification of innovative activity. The ecosystem's tools and services provide access to technology and financial and human resources, protect the results of intellectual activity, and allow for the use of digital systems for managing innovative projects and research and development (R&D). Accelerated testing and piloting of R&D results in the ecosystem with subsequent commercialization is offered.
- Accessibility of new markets. The ecosystem creates new markets and provides access for small and medium-sized enterprises thereto. Administrative, consulting, marketing, and financial support to export companies is provided.
- Reducing corruption risks. The principle of digital transparency increases the coordination of economic relations between the ecosystem entities, ensures traceability and transparency of operations, and allows one to quickly eliminate legal and regulatory barriers that create corruption precedents.

The introduction of cross-sectoral ecosystems in the industry will allow for the intensification of the innovative development of high-tech industries and ensure the retention of leadership positions in the high-tech sector. High-tech sector is represented by a set of industries characterized by a high level of R&D costs and advanced scientific and technical potential. The enterprises of the sector create advanced technical solutions and have the rights to the results of world-class intellectual activity, provided with the highest category of personnel, and are competitive in the world market.

The level of expenditures on R&D in the sector exceeds 6% of the money turnover ^[43].

An example of organizing cross-sectoral interaction is the initiative to create a single ecosystem of cross-sectoral cooperation within the Eurasian Economic Union, which includes tools for industrial cooperation, staffing, and educational and logistics infrastructure.

Currently, the development of industrial production of unmanned aircraft system (UAS) for civil applications is an urgent task in Russia. Many strategic programs and documents are devoted to solving this complex problem, including the Strategy for the Development of the Information Society in the Russian Federation for 2017–2030 and others ^{[44][45][46][47][48]}.

Herein has made an attempt to attempted to solve this large-scale problem by proposing the mechanism of the cross-sectoral ecosystem for strategic development of high-tech industries.

The creation of cross-sectoral ecosystem for the development of civil UAS is relevant due to cross-sectoral nature of its production. Ensuring cooperative links between related industry enterprises, dynamic development of production by small companies and start-ups, training of personnel for the unmanned industry, development of a regulatory framework, and the removal of regulatory barriers requires overall support for interaction between the actors in an actively emerging market.

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