Opportunities for universities to use the German experience in the startup ecosystem development

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Abstract. The paper analyzes modern theoretical concepts of the startup ecosystem. The subjects of the startup ecosystem are studied, and their main functions are presented. The current state of innovation ecosystems in German universities is analyzed, and the prospects for their development are determined. The essence of the main components of university innovation ecosystems is revealed, and the principles of their formation and implementation are determined. The features of the innovation ecosystem development in German universities are investigated. The directions of the innovation ecosystem formation in Russian universities are shaped.

1. Introduction
In recent decades, the focus of the analysis of economic phenomena and processes has shifted to the category of evolutionary theory referred to as ecosystem. This is due to the fact that, similarly to natural systems, various types of economic systems develop as a result of interaction between its components, their variability, mutual adaptation, as well as processes similar to natural selection [1], which is the result of technological knowledge accumulation [2].

The term ecosystem was first used in 1935 by the English botanist A. Tansley. Earlier, the unity of organisms and the environment was addressed in works by the German researcher K. Moebius, American biologist S. Forbes, and Russian scientists V. Dokuchaev, G. Morozov, and V. Sukachev. After that, D. Moore coined the term business ecosystem in 1993, and the concept of ecosystems has developed essentially in socio-economic disciplines. Within the subject matter of this paper, the terms innovation ecosystem and startup ecosystem interrelated by their target orientation deserve significant attention. The essence of the concept of innovation ecosystem is revealed in a number of studies of the last decade [3].

According to D Jackson, innovation ecosystems unite two important and largely separate economies – the knowledge economy, which develops on the basis of fundamental research, and the commercial economy, which is driven by the market [4]. An innovation ecosystem is formed due to the presence of not only a dynamic set of economic agents and institutions engaged in innovation-oriented activities, but also due to a dynamic set of their multidimensional internal connections [5].

The strategic entity, which plays an important role in the ecosystem, is startup companies at different stages of the life cycle and potential participants in startups, which are individuals with or without experience in innovation-oriented entrepreneurship who use their intellectual potential to generate new ideas and develop commercially viable innovative products and services.

Other entities belong to the ecosystem due to their ability to sustain startups. Functioning of different organizations, institutions and individuals as entities of the startup ecosystem is performed...
with regard to one of five key areas needed for successful startup development: 1) government regulation, 2) startup financing, 3) training of startup participants, 4) information support, 5) startup infrastructure support. Table 1 lists the entities of the startup ecosystem and their main functions.

Table 1. Entities of the startup ecosystem and their main functions.

| No | Startup ecosystem entities | Main functions |
|----|-----------------------------|----------------|
| 1  | Startup companies at different stages of the life cycle and potential startup participants | Generate new ideas, develop and bring commercially viable innovative products and services to the market |
| 2  | State central and local authorities | Form the legal framework for entrepreneurship, policy in the field of innovation-oriented entrepreneurship and protection of intellectual property rights |
| 3  | Investors: private and public capital, business angels, venture capital, investment companies and funds, crowdfunding platforms | Finance startup projects at different stages of the life cycle |
| 4  | Competence centers: universities, research institutes, high-tech companies | Form the professional and business competence of startup participants, act as potential partners of startups |
| 5  | Experts: professional consultants, technical and business experts, mentors, lawyers, and trainers | Provide professional consulting services to start-up participants and help to increase their professional competence in the process of developing innovative products |
| 6  | Coordinating bodies: governmental and non-governmental committees, working groups, professional associations and unions | Perform coordination in the ecosystem, create platforms for interaction between ecosystem participants (holding meetings, conferences, competitions, exhibitions, presentations, master classes, etc.), promote communication channels and development of networks for knowledge exchange between the subjects of startups and increase the competence of participants in startups |
| 7  | Agents of change: bloggers, journalists, well-known politicians, businessmen, public figures, social groups | Provide information support to the ecosystem, shape the attitude of society towards startups, facilitate their popularization, promote innovative ideas and products |
| 8  | Infrastructure companies: business incubators, business accelerators, technoparks, innovation centers, etc. | Provide infrastructure support for startups – workspace, office equipment, communications, etc. |

* Source: compiled by the author.

In theory, the ecosystem of startups is an innovation subsystem. They are united by a common goal (creation and launching of innovative products on the market), similarity of the ecosystem entities, their functions and interrelationships, and the environment. The focus on the startup ecosystem as an independent object was due to the rapid growth of the global startup industry. Dow Jones Venture Source reports that in 2018 in the United States the volume of venture capital investments grew by 47% due to multimillion-dollar investments in startups [6]. Over the past few decades, startups have created more jobs compared to traditional companies.
The Europe’s leading hub for startups and tech companies is Germany, the country with the largest population in Europe and a diversified economy. Technologically savvy and resourceful Germans provide an excellent base to support startups in their national and international development. Many of these startups involved in different industries and fields of activities function through software or a cloud platform. Most of these startups are technology-driven, nevertheless, many of these companies are also involved in the financial sector, one of the most attractive sectors for failure and accelerated growth. However, in the scope from e-commerce to industrial applications, from transportation to artificial intelligence, many German startups adopt technologies in new verticals and disrupt a wide range of industries.

They are probably not as well-known as well-established German digital corporations such as Rocket Internet or Zalando. However, many of these companies have already been recognized in Germany and abroad and covered a large segment of the population to sell their products and services. Other companies are not well known to the general public as these startups focus on specific business niches. In addition, startups often compete with each other, especially in highly competitive financial services and FinTech industries. However, a number of leading German startups have already achieved Unicorn status, which is valued at over $1 billion.

The aim of the paper is to study positive experience of the formation and development of innovation ecosystems in German universities, and to clarify functions and areas of their business.

2. Analysis of recent studies and publications
In recent years, many foreign scientists, such as M Russell [7], I Maxwell [8], G Chesbrough [9], G Itskowitz [10], and others, have researched theoretical and practical provisions of the formation and development of innovation ecosystems. A review of existing interpretations of innovation ecosystems shows a universal nature of the level of their formation and development. In the scientific literature, there are the concepts of innovation infrastructure and innovation ecosystem, and the latter has gained great popularity in recent years. In the literature, these concepts are identified and considered as synonymous; however, our analysis revealed significant differences between them. In particular, the innovation infrastructure is one of the component s of the innovation ecosystem, which is understood as a complex system of components that are in complex network-type interrelation to create and implement innovations through intensive dissemination of knowledge and information and resource-sharing. A literature review identified the main components of innovation ecosystems, which are as follows: higher education institutions, research institutions that supply innovations for commercialization; the venture capital market, which provides financial resources for innovations, development of innovation ecosystems and their implementation in business structures (venture funds, asset management companies, business angel networks); innovative infrastructure to support entrepreneurship (material support: technoparks, business incubators and accelerators, development institutions, and non-material support: service companies to meet the needs in accordance with the specifics of the work of innovation-oriented companies); small and medium-sized business, demand for high-tech products, technologies and startups; regulatory framework to create conditions for emergence and support of innovators. The efficiency of ecosystem functioning depends on the quality of interaction between all its components. It should be noted that in conditions of insufficiently developed infrastructure, nationally innovation-oriented universities take the initiative to create individual local ecosystem components. Thus, under conditions of the Russian economy, it is relevant to study the best world experience in formation of the university startup ecosystem, as a place for generation, accumulation of innovative scientific and technological knowledge and development of creative entrepreneurship. Universities play a large role in formation of innovation ecosystems. The research conducted by the author made it possible to identify important links in such ecosystems that are involved in the creation, financing and implementation of startup projects (Figure 1).
3. Presentation of basic material of the study

Despite a significant contribution of various researchers to development of theoretical principles and practical recommendations for implementation of innovation ecosystems, startup ecosystems in Russian universities are developed insufficiently and require further research. Russian ecosystems are currently being formed; therefore, it is expedient to analyze the best world practices of the startup ecosystem support.

Germany shows a steady pace towards the title of ‘startup queen’. This was preceded by introduction of a number of state measures, construction of innovation university startup ecosystems and increased efficiency of innovation commercialization in universities. The German experience shows that Berlin, Darmstadt, Frankfurt am Main, Luneburg, Kassel, and Munich are the most famous and successful university cities in Germany that have organized effective startup ecosystems.

With regard to the success of Germany in startup development, the features of formation of the entrepreneurship innovation ecosystem in this country has been investigated. Germany has a good infrastructure for startups and provides a wide range of tools to support innovation-oriented entrepreneurship. According to statistics, every second startup in Germany emerges due to the desire of young researchers to implement their bold business ideas but not to gain significant profits. This contributed to the increase in the number of startups in Germany that has almost tripled over the past five years [11].

According to various estimates, about 6 thousand startups are currently functioning in Germany. Since 2012, startups have created about 80 thousand new jobs, and Berlin is considered the European capital of startups, which attracts many young entrepreneurs. In 2015, almost 3.1 billion euros were invested in German startups, which is almost five-fold more than in 2013 and almost 4 fold more than in 2014. The bulk of funds (1.8 billion euros) fell on startups in the consumer services industry, as well as online retailing. The second place is occupied by the so-called FinTechs, that is, startups offering new financial and insurance services. These online startup platforms compete with traditional German banks and insurance companies [12].

The capital of Germany, Berlin, is called the capital of startups. Berlin is home to the headquarters of startups with the largest trade turnover, whereas Munich, Hamburg, Cologne, Dusseldorf, Stuttgart and Frankfurt am Main are quite attractive in terms of infrastructure availability for startup development. Berlin has more artificial intelligence startups than any other German ecosystem, and it is expected to generate more than $ 2.2 billion in revenue by 2025. Berlin is home to world-renowned centers such as the German Research Center for Artificial Intelligence and the Berlin Center for Machine Learning. For many entrepreneurs, good higher education institutions and rents, which are still low in Berlin compared to other large cities, are key benefits.
Munich-based startups see their proximity to universities as a particularly beneficial factor for development. The following universities in Munich offer effective support for entrepreneurship:
- Technical University of Munich (TUM), a leading university for startups in Germany. Based on the California model, its subsidiary Center for Innovation and Business Creation, Unternehmer TUM, has been launching 70 startups per year since 2002.
- Ludwig Maximilian University of Munich (LMU), ranked fourth in Germany for effective support of startups provided by its Center for Entrepreneurship.
- The Social Enterprise Academy of Munich (SEA) established to help young social enterprises [13].

A distinctive startup ecosystem in Germany began to emerge along with the internet economy, which has increased the interest of entrepreneurs and investors in digital e-commerce. The spread of startup activities in Germany was induced by the university environment and supported by innovation programs, which were developed to train students to launch their own startups along with traditional educational programs in economics and management. At the same time, new structural units are being established in German universities for training young men and women to work in the digital economy. As evidenced by leading universities, the main functions and directions of startup ecosystem development in Germany are as follows:
- interaction with business, government and the venture capital industry;
- teaching the theory and practice of entrepreneurship;
- research in the field of entrepreneurship;
- consulting services to entrepreneurs, mentoring for emergent entrepreneurs (business team formation);
- organization of conferences, competitions of business plans, club events;
- development of entrepreneurial networks and communities;
- development of innovative infrastructure, including science parks, business centers;
- formation of a policy for universities focused on development of entrepreneurship, creation of the so-called entrepreneurial universities;
- strengthening of the entrepreneurial spirit and development of innovation-oriented culture [14].

The startup boom plays a critical role in the economic development of Germany: young enterprises generate innovation, create new jobs and provide significant competition to big business. In recent years, there has been a significant increase in the number of startups in the digital sphere. This is due to the support provided by the German federal government, which approved the Digital Agenda 2020 that lists measures to strengthen the international competitiveness of the digital economy and makes Germany a ‘number one digital growth country in Europe’. Back in 1998, the Federal Ministry of Economics and Energy (BMWi) established the so-called EXIST-Scholarship for Business Startups for university students and graduates. In addition, BMWi invests in the High-Tech Gründerfonds that together with the Credit Bank of Reconstruction (KfW) and 18 other business investors support early-stage technology startups [15].

The largest private investors in Germany, primarily Rocket Internet headquartered in Berlin and the German Startups Group, support startups that show rapid growth and significant profits. In addition to these two giants of the venture capital industry, many domestic investors invest in digital business models. Germany is one of the most attractive countries for foreign investors. German startups are of primary interest for US investors who are able to significantly expand the amount of available investment resources.

Most German startup companies (84.1%) use their capital as a source of funding, and only a third (30.2%) raise capital from their families or friends. Other external sources of funding for startups in Germany in 2018 were government funding (35.5%), business angels (22.6%), venture capital (18.8%), and incubators and accelerators (8.3%).

Startups in Germany commonly emerge in university incubators. These incubators provide company founders with premises and consulting services in the first instance, which contribute to
success of the projects [16]. Table 2 summarizes the services provided by German university incubators to startup founders.

**Table 2.** Leading university incubators in Germany and their characteristics.

| University and incubator | Characteristics |
|--------------------------|-----------------|
| Berlin University of Applied Sciences (Berlin), Start Up Gründerwerkstatt incubator | Provides scholarships for startups based on funding from BMWi and the European Social Fund, Berlin. To qualify for a startup scholarship, all alumni and students from all over Germany are eligible to participate. Incubator assistance may include: - scholarships for startups up to 4 000 euros per month per team; - equipped offices in Gründerwerkstatt (free of charge) with internet and media access; - financial support for development of prototypes, etc.; - seminars and advisory support, as well as mentoring provided by university professors. |
| Career Center at the University of Applied Sciences (Darmstadt), Campus Dieburg central incubator | The incubator is designed for university students and graduates and provides offices or workspaces. Participants receive advice and training from the Career Center, and from the Starkenburg Consulting Agency team. |
| Goethe University (Frankfurt am Main), Goethe Unibator incubator | Supports students and university staff on the way to establishment of their own company to create products or services based on scientific discoveries and inventions. Goethe Unibator offers mentorship program for startups, an international network of experts, and access to investment fairs such as the CeBIT IT fair. The incubator provides offices and technical infrastructure. |
| Goethe University (Frankfurt am Main), Main Incubator | The incubator is responsible for training of students and graduates of Frankfurt Graduate School. Provides free access (within the first six months) to modern offices. A training program that includes the basics of business is available. |
| Leupgan University (Luneburg), Leuphana incubator | Provides emergent innovators with educational services. Companies receive advice and assistance at an early stage. The offer concerns both university students and those who want to start a business outside the university. |
| University of Kassel (Kassel), Uni Kassel Transfer incubator | Offers advisory support and offices for founders. Coaching and orientation sessions cover all significant issues related to business set up. Maintains close relationships with experts. Applicable to students, alumni and scientists of the University of Kassel. |
| Ludwig Maximilian University (Munich), LMU EC Lab | The LMU Entrepreneurship Center is the EC LMU laboratory for emerged teams. Teams develop business plans, prototypes and conduct initial market tests. The main activities of the laboratory include: - financial support: offices, conference rooms, modern IT equipment; - mentoring for each LMU EC Lab team; - availability of experts and venture capitalists; - legal and financial consulting; - establishing contacts at regular events; - educational services such as seminars and lectures. |

* Source: compiled by the author.

German universities are actively involved in the development of technoparks, which are supported by national industrial companies that determine the areas of joint innovation activities. The favorable
ecosystem in Germany makes it possible to quickly transform an interesting idea into a successful project. This applies primarily to the information technology market. For example, the University of Duisburg-Essen in collaboration with the Degussa enterprise has created a technopark as part of the Greavis project focused on solving research problems of the holding company [17].

4. Conclusions and proposals
According to the data available, at the beginning of 2020, in addition to the startup ecosystems in Moscow and St.Petersburg, there were 12 more regional ecosystems of innovation-oriented entrepreneurship: in Vladivostok, Kaliningrad, Yekaterinburg, Novosibirsk, Voronezh, Samara, Perm, Izhevsk, Yakutsk, Krasnodar, Nizhny Novgorod, and Kazan. The Association of Innovative Regions of Russia includes 16 federal subjects. However, there are only 6 startups per 1 million urban people in Russia. At the beginning of this year, there were about 700 technology startups in our country [18].

University innovation ecosystems in Russia are still being formed, but the first steps have already been taken towards creating business schools for development of startup entrepreneurship in universities [19]. Thus, a number of successful technology companies are directly associated with specific universities. For example, MIKRAN and TUSUR (Tomsk), Speech Technology Center and ITMO (St. Petersburg), Novosibirsk Scienceopolis and Novosibirsk State Technical University, Siberian State University of Telecommunications and Informatics, Novosibirsk State Medical University, Quantum Technologies and Moscow State University (Moscow), Technologies of Distributed Registers and St. Petersburg State University (St. Petersburg), Artificial Intelligence and MIPT (Moscow) and some others. In addition, formation of a network of flagship universities creates prerequisites for promotion of applied innovation activity in universities.

The experience of development of the startup ecosystem in Germany is important for our country in terms of the need to establish adequate infrastructure facilities to support creative entrepreneurship and to introduce various instruments of the state support for startups. In particular, Russian universities should focus on creating platforms for innovation ecosystems. Therefore, the study and implementation of best practices of Germany is of critical relevance.

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