

пояснити тим, що в процесі перекачування масла утворені в результаті кавітації мікробульбашки, які є зародками кавітації, не встигають повністю видалитися з системи.

Аналіз досліджень показав, що світловипромінювання залежить від реологічних властивостей рідини. Більш інтенсивна там - де менша в'язкість. Отримані експериментальні дані були апроксимовані на можливість використання математичної моделі гідродинамічного кавітаційного генератора і дозволили врахувати властивості робочого тіла.

На підставі виконаної роботи можна зробити висновок про те, що причиною виникнення гідродинамічної люмінесценції є тертя рідини об стінки каналу і світловипромінювання подвійних електричних шарів.

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ENGINEERING AND TECHNICAL FACILITIES OF INFORMATION EXCHANGE INNOVATIVE ECOSYSTEMS CREATING

Introduction

One of the priority directions of the post-war reconstruction of Ukraine is the creation of innovative technologies for information exchange (IE) facilities. This direction is based on such technologies as printing, telecommunications, information, etc.

It is possible to combine the mismatch between educational, scientific and innovative activities and the real economy sector through public-private partnerships in the educational and scientific sphere, which should be carried out by universities.

The history of innovation in Ukraine should be unique and successful. Such a result can be achieved if the following steps are implemented:

- foreign innovations implementation into the Ukrainian economy: technology transfer; opening of representative offices of foreign high-tech enterprises; creation of joint ventures on the territory of Ukraine;
- solving scientific and technological problems and fulfilling orders for innovative products from state institutions and business structures (armed forces of Ukraine, state and regional management bodies, Ukrainian and foreign companies, their associations, foundations);
- development of a “factory” of ideas and innovations, cultivation of start-up projects, creation of micro- and small high-tech enterprises, introduction of their innovative products to the markets, interaction with international venture funds. Entrepreneurship education in Ukraine is gradually developing, but there is still no systematic approach to education in educational institutions. At the level of higher education institutions, the “Entrepreneurial University” initiative was launched, and several student incubators and accelerators were also created¹.

In the global educational space, there are 4 models of university development, but only two have a working public-private partnership mechanism:

- “University 3.0” – innovative and entrepreneurial;
- “University 4.0” – ecosystem - biodigital.

The most striking example of the “University 4.0” model is Stanford University (USA). In Ukraine, for example, the National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” (KPI) on the way from the “University 3.0” model to the “University 4.0” model.

KPI is gradually creating an innovative ecosystem “Sikorsky Challenge Ukraine» (SCU), the components of which are:

- international festival of innovative projects (startups);
- innovative holding;
- scientific park;
- startup school;
- business incubator;

The All-Ukrainian Innovation Ecosystem SCU (innovation HUB) is an open innovation ecosystem that unites the country’s institutions interested in the development of the Ukrainian innovation economy: universities, scientific institu-

¹ Development of the innovations ecosystem in Ukraine // ECONOMIC RECOVERY CENTER, April 2023, draft

tions, state authorities and local governments, business companies, foundations and public organizations.

Research Methodology

The engineering and technical approach to the innovative activities organization allows creating appropriate facilities. Among them, it is possible to single out the development of innovative ecosystems in the form of HAB - infrastructure². This allows to significantly increasing the innovative projects effectiveness by the modern social challenges conditions. At the same time, innovative activity is directly related to the features of the country social state (Fig. 1). The successful implementation of innovative projects is determined by the perfection of the existing design area for carrying out design work (Fig. 2). Such a design environment in the form of entrepreneurial IE ecosystems are mainly focused on innovations, generating new business models, products and services, in addition to creating more competitive and efficient markets and improving the customer experience.

These ecosystems - driven by governments, entrepreneurs, foundations and educational institutions, and mainly the private sector - demonstrate that they can create a more dynamic economy by attracting ambitious and talented entrepreneurs, by generating creative thinking environments and entrepreneurial activities³.

There are several key factors that foster ecosystem growth and capacity:

1. **Density as a pole of attraction.** Ecosystems are generally concentrated around their primary industries, typically in large cities, except for the agricultural or livestock sectors, which are concentrated in rural areas. It must be understood that this is not about the number of people or companies that are operating in the country, but about how close and interconnected they are. Density attracts talent, investment, aid, and research.

2. **Availability of investment.** An ecosystem must be a meeting point where money flows, both from public and private funds.

3. **Industry maturity.** The maturity of an ecosystem refers to the stage of development of companies, as well as the experience of entrepreneurs and employees. The generation of companies with high profits, as well as

2 Shtefan Ye. Modeling of research hub – infrastructure creation for innovative projects //First international conference “OPEN SCIENCE AND INNOVATION IN UKRAINE 2022” : Proceedings, October 27-28, 2022. / Ministry of Education and Science of Ukraine; State Scientific and Technical Library of Ukraine. – Kiev : Ukrainian Institute of Scientific and Technical Expertise and Information, 2022. <http://doi.org/10.35668/978-966-479-129-5>

3 EU4Digital: supporting digital economy and society in the Eastern Partnership Guide for building the IE entrepreneurial ecosystems in the Eastern partner countries: Maturity analysis and recommendations , March 2021. 225p.

the “exit” generated in mergers and acquisitions, make these entrepreneurs return to the market, either as entrepreneurs with higher capacity for success or as investors.

4. **Specialized talent.** It has to do with the availability of people trained and specialized in companies, not just employees, but also support staff (lawyers, managers, mentors and advisors, among others).

5. **Education.** There is a culture of support for innovation and entrepreneurial values in the most mature ecosystems across all social stages, and a great deal of connectedness between universities and newly created companies.

6. **Friendly environment.** Understood the facilities for business creation, tax incentive policies, investment aid, workplaces, etc. An ecosystem must strengthen the population and institutions’ entrepreneurial attitude and culture.

We can then declare that an entrepreneurial ecosystem’s primary mission is to unite all the resources that allow entrepreneurs to face all stages from their business “Idea” to the generation of “Profits”. The detail stages that show this path are presented by the start-up lifecycle (fig.3). The graph presented on Fig.3 help us to understand the resources and elements that an ecosystem must offer to its entrepreneurs:

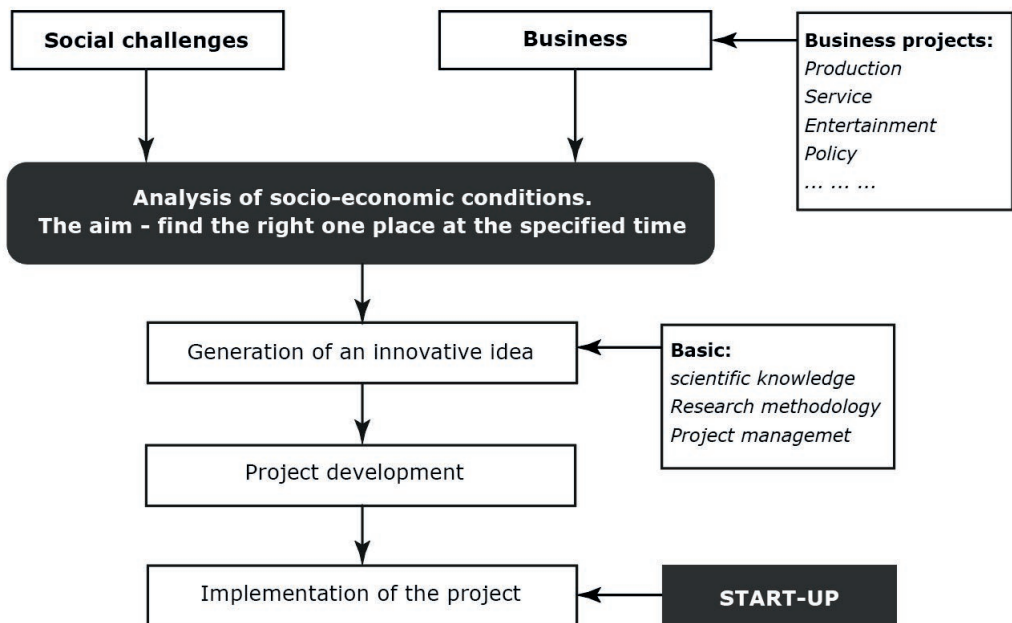


Figure 1. The innovative activity basis

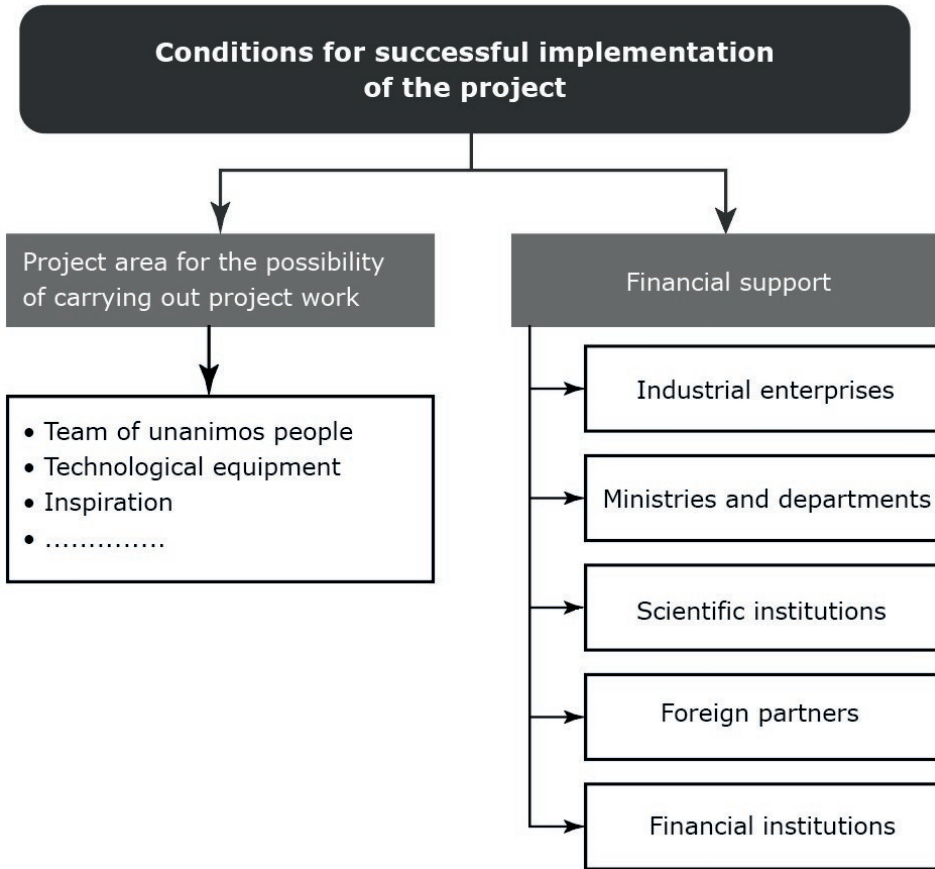


Figure 2. The main elements of successful implementation of innovative projects

1. **Talent:** The actors' first mission in an ecosystem is to detect talented entrepreneurs—individuals with the soft skills described previously, ready to execute and transform viable business ideas into highly profitable companies.

2. **Idea:** Talented people need to find viable sources of business ideas. This is important in ecosystems where entrepreneurs are young, with little experience on the labour market, and little experience detecting a business need.

3. **Start-ups:** Talent with viable ideas, generates new companies. In this phase, the ecosystem actors must support the creation of work teams and the development of business strategies that the entrepreneur will face in the short and medium-term.

4. **Sales:** Companies, with reliable and multidisciplinary teams begin to generate sales. In this phase, ecosystem actors must support companies in making sales by connecting them to future markets and customers.

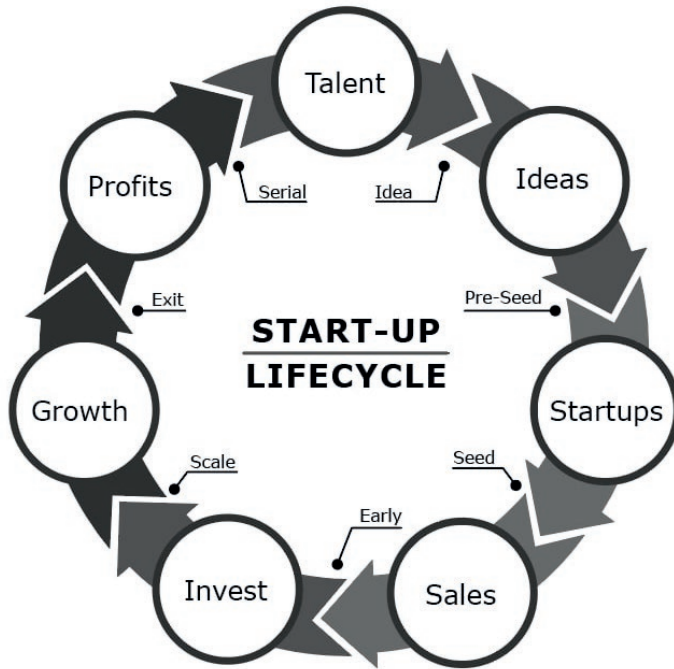


Figure 3. Start-up lifecycle scheme

5. **Investment:** The companies that generate sales demonstrate that both the entrepreneurial team and the product, as well as the business model, are correctly validated, and this attracts the interest of investors.

6. **Growth:** Companies that have investment generate expansion and growth. In this phase, the ecosystem actors must support the entry of companies into new markets through their internationalization.

7. **Profits:** Companies that have escalated into markets and sales generate profits for entrepreneurs, either through sales or through the sale of the company via mergers and acquisitions. These entrepreneurs have gone from being simple, talented people to expert entrepreneurs who will reinvest their profits in the same ecosystem, either by creating new, more dominant companies or by investing in other entrepreneurs.

Each of the growth phases takes place in stages, which are broken down into the idea stage, pre-seed stage, seed stage, early stage, and scale-up from talent to profit.

From the “idea” stage to “scale-up”, start-ups always have the same primary objectives. These stages are crucial for the start-up’s success. The stakeholders of the ecosystem act with the most intensity by offering the resources that the entrepreneurs and start-ups need: business knowledge, capital, market & business environment, resources and regulations (fig. 4).

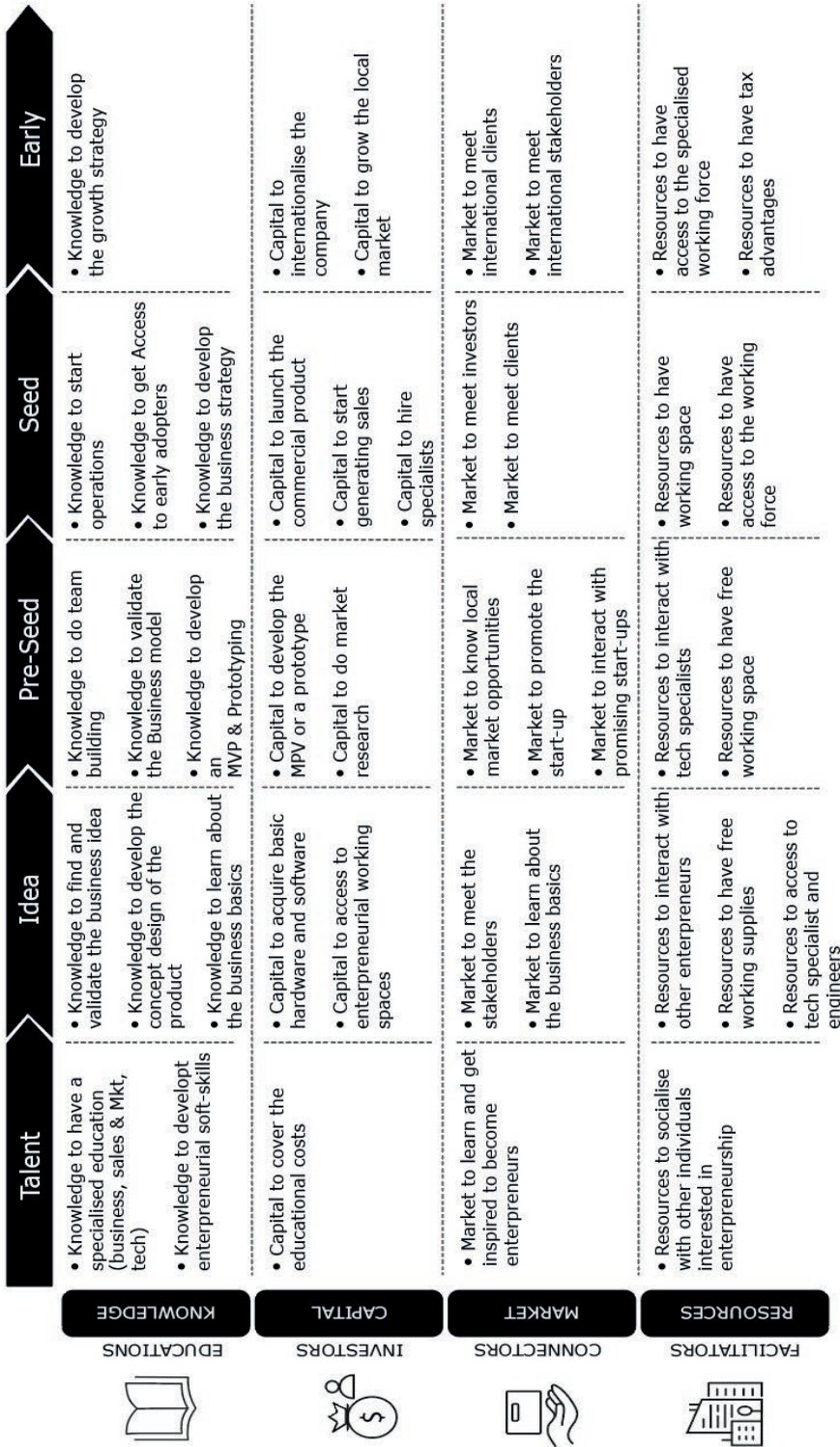


Figure 4. Primary objectives per start-up growth stage

During the “Idea stage”, the primary mission of the entrepreneur is to validate the idea of minimizing risks, using “lean” methodology concepts, through interviews with future clients, analysis of entry into a large market, design of a competitive product in the market, and to have a clear and attractive value proposition. On the other hand, two key factors are developed: the creation of a team of entrepreneurs and a personal financial plan.

During the “Pre-seed stage”, the entrepreneurs’ main objective is to validate their business models through the proof of concept of their prototypes and minimum viable products with future clients.

During the “Seed stage”, a commercial product is created, with which the first customers are obtained. During this phase, the strategy of customer acquisition, acquisition costs, average customer life, average income, etc. allow entrepreneurs to create a viable business plan that helps to chart the growth strategy.

During the “Early stage”, the start-up’s principal objective is to consolidate as a company reaching the breakeven point, between sales and costs, mainly in local markets.

As a “Scale-up”, the primary mission is to increase revenues and generate profits. Essential tasks are developed, such as growing in existing markets with new products or services, establishing alliances with international partners and accessing new markets.

Since no standard methodology to evaluate an IE entrepreneurial ecosystem’s capacity is universally used, nor does it cover all aspects of ecosystem building across the start-up’s lifecycle, the experts have applied a custom methodology for evaluating the maturity of the IE entrepreneurial ecosystems and the performance of their stakeholders ³. The methodology was defined based on the objective of offering concrete recommendations and practical actions for the ecosystem’s growth. It is based on several assumptions:

1. The primary goal of the IE entrepreneurial ecosystem is to have the capacity to generate highly profitable start-ups. Those highly profitable start-ups should re-invest their profits and human capacity to new start-ups.

2. Start-up’s lifecycle goes from an idea to profits through different growth stages: idea stage, pre-seed stage, seed stage, early stage and scale-up (fig.3).

3. The conversion ratios of the IE entrepreneurial ecosystem start-ups growing from one stage to another are calculated to measure the ecosystem wealth. Conversion ratios of start-ups can be considered a common standard at the international level to evaluate the wealth of the entrepreneurial ecosystems.

4. The essence of the IE entrepreneurial ecosystem is to guide the start-ups from business ideas to profits by supporting their growth through offering access to business knowledge, capital, market, and resources during the different growth stages of the start-up's.

5. Different stakeholders compose and influence the development of the IE entrepreneurial ecosystem:

- *Educators*: Offering start-ups access to knowledge.
- *Investors*: Offering start-ups access to capital.
- *Connectors*: Offering start-ups access to market.
- *Facilitators*: Offering start-ups access to resources.

The methodology consists of connecting the steps followed by experts in the IE entrepreneurial ecosystems evaluation process.

The logical flow of the methodology is presented in the figure 5. In the final step (fig.5), a total of 41 recommendations were composed and prioritised taking into account the level of performance of the stakeholders³.

The main objective of the recommendations is to boost the growth of the entrepreneurial ecosystem by empowering its stakeholders, for which the recommendations are grouped into three categories:

1. "*Creating the stakeholders*": When the evaluation level is "Non-existent", the category of the recommendation is "Creating". The recommendations of "Creating" type propose specific activities to create and make sustainable non-existent actors in the ecosystem.

2. "*Empowering the stakeholders*": When the evaluation levels are "On performance" and "Acceptable performance", the category of the recommendation is "Empowering". The recommendations of the "Empowering" type propose specific activities to support the sustainability of the ecosystem's stakeholders.

3. "*Boosting the stakeholders*": When the evaluation levels are "Optimal performance" and "Excellent performance", the category of the recommendation is "Boosting". The recommendations of the "Boosting" type propose specific activities to support the growth of the ecosystem stakeholders.

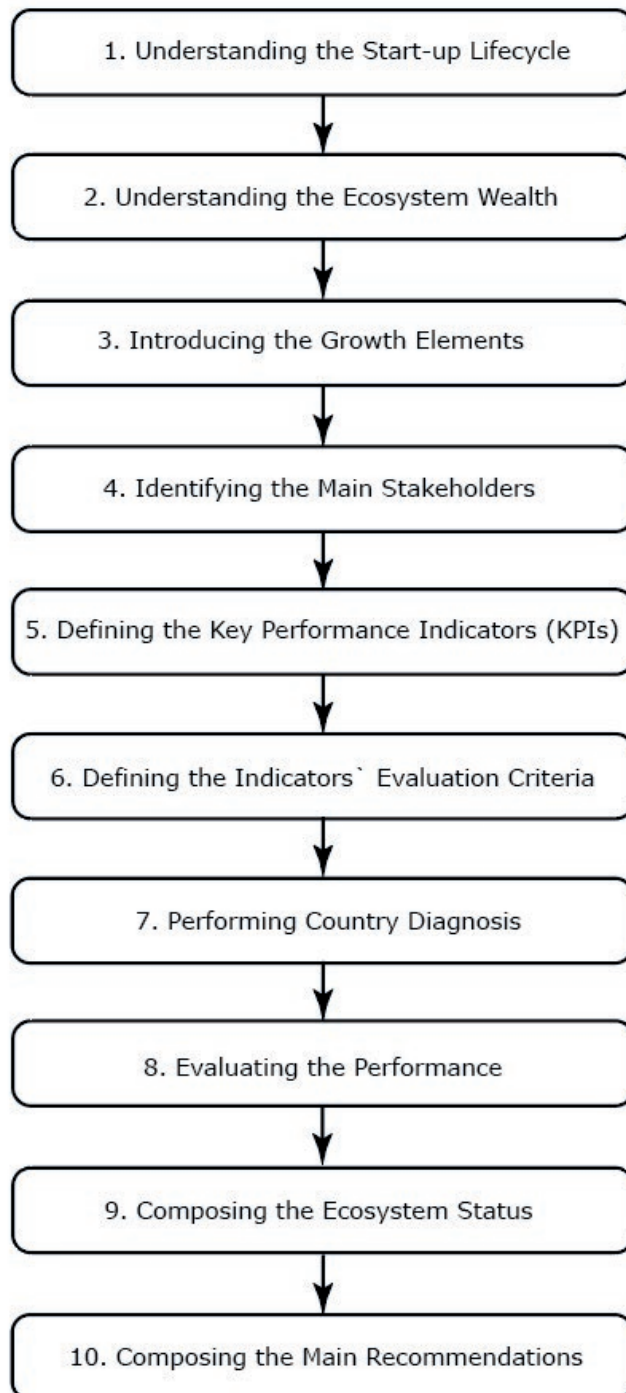


Figure 5. Methodology algorithm of entrepreneurial ecosystem evaluation

In addition, each recommendation is composed of the following elements:

- **Title:** Name of recommendation.
- **Area:** Resource that the recommendation impacts (knowledge, capital, market and resources).
- **Target:** Type of stakeholders targeted by recommendation (educators, investors, connectors and facilitators).
- **Implementer:** Type of capacity builder responsible for the implementation of the recommendation
- **Executor:** Type of entity responsible for executing the activities of the recommendation.
- **Related indicator:** Performance indicator that defines the recommendation.
- **Actions:** Concrete actions necessary to implement the recommendation.
- **Complexity:** Different types of resources (budget, timing, set-up budget, operational budget) and their complexity level that is required to implement the recommendation. Each resource is evaluated on a five level scale of the complexity of implementation, ranging from “Very Low” to “Very High”. Also, the amount and implementation period of each resource is estimated, where applicable.

In the end, the experts prioritized and indicated the most necessary and impactful recommendations for the growth of the IE entrepreneurial ecosystem at the country level.

Results and Discussion

An “Entrepreneurial ecosystem” can be defined as the union of public and private entities, within a local, national or international scope, that joins efforts to promote the creation of new companies and ensure their success, by offering them access to knowledge, capital, market and resources, so that these highly profitable companies will invest their profits in the same ecosystem, thus creating economic wealth and boosting industry (fig. 6). The system combination of ecosystem elements (fig. 6) is carried out by the matchmaking procedure (fig. 7).

For the effective functioning of a competitive entrepreneurial ecosystem, it is necessary to use rational tools in the form of space-time structures (project areas).

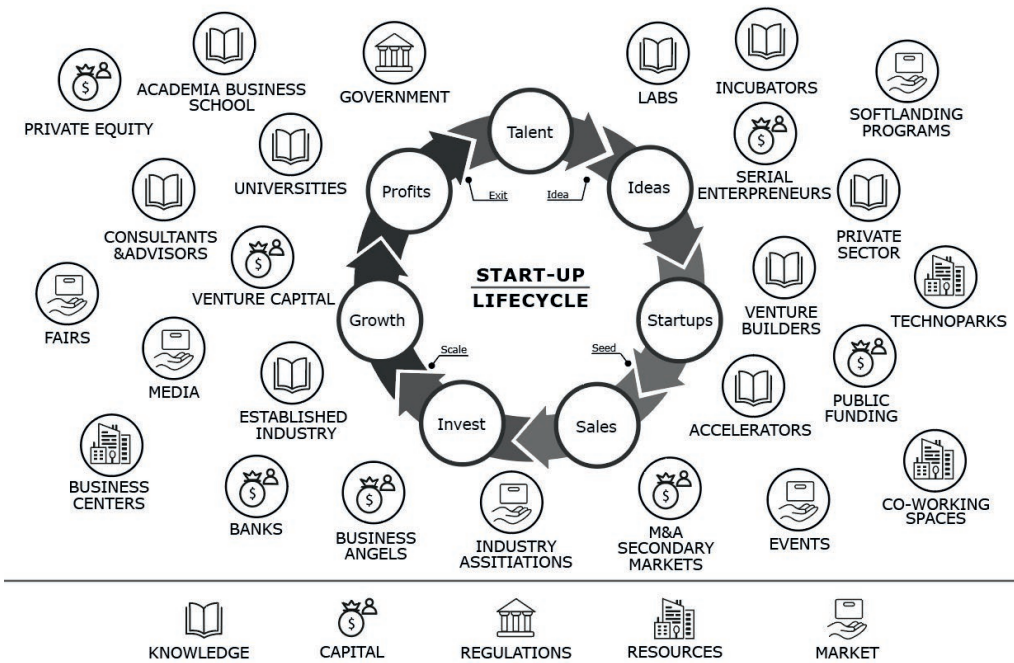


Figure 6. Information exchange entrepreneurial ecosystems stakeholders

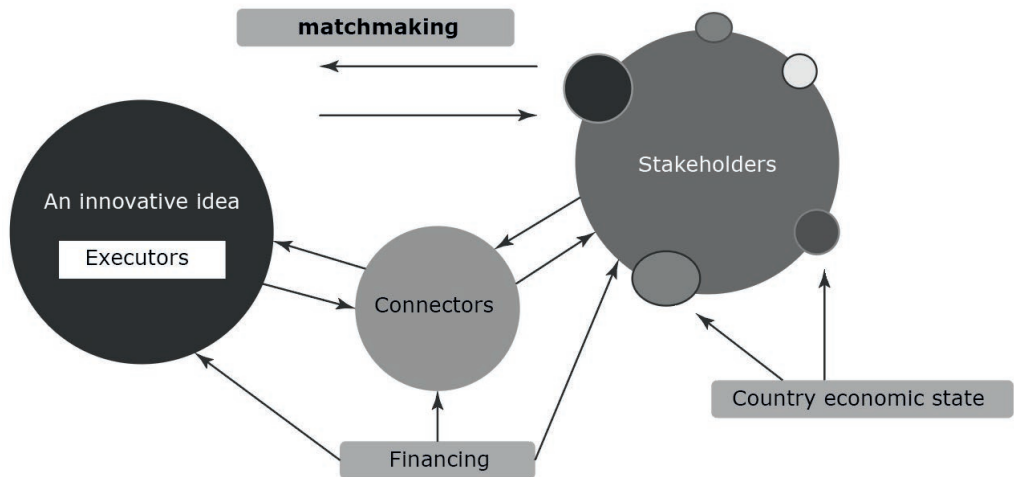


Figure 7. Matchmaking procedure for entrepreneurial ecosystems creation

The basis of the proposed methods of creating a research area is the idea of its structural organization in the form of HUB⁴. Each element of the future research area (start-ups, researchers, scientific and industrial institutions, ministries and

⁴ The central and most active part or place. Innovation HUBs have been widely celebrated by practitioners and policy-makers for their ability to boost creativity and collaboration.

departments, consortia, stakeholders, etc.) is presented in the form of conventional circles with the appropriate set of competencies – •, that focused on innovative problem solving (Fig. 8).

On the basis of the principle of analogies, a structural diagram and a mathematical model of the creating process and functioning of a suitable innovative HUB were developed in the form of a coaxial mechanism with elements conditionally rotating with the corresponding angular velocities Ω and (t) around a single center - an innovative & project idea (Fig. 8 b). The successful functioning of the such type HUB is based on the coordination of the angular velocities of rotation of the constituent elements $\Omega_i(t)$ (which conventionally determine the generalized indicators of economic efficiency) taking into account the corresponding radii of rotation R_i (conditional indicators of the of the HUB participant size), the number of competencies K_i for each HUB participant and interaction forces between the HUB elements (imagine indicators that describe the financial flows).

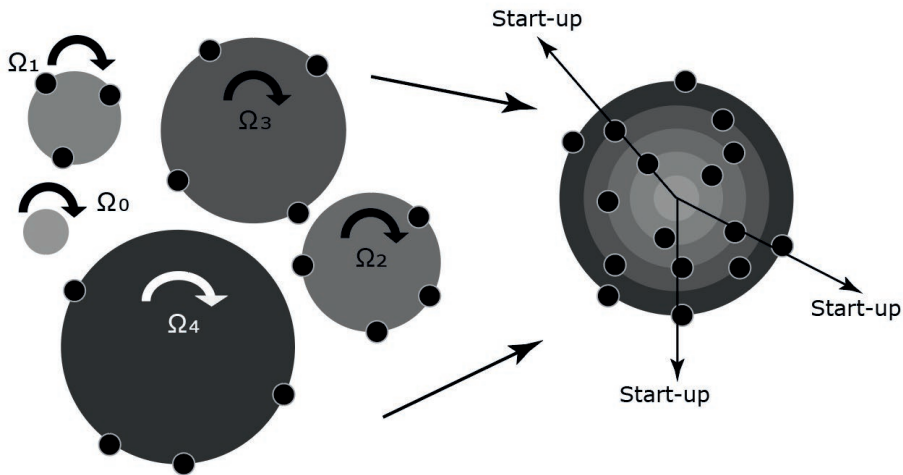


Figure 8. The project area creation scheme

A mathematical model of the entrepreneurial ecosystems creation process for the proposed form of the HUB has been developed ². In a generalized form, the mathematical model is represented by a system of functional dependencies: $\Omega_i, R_i, P_i, K_i, t, \Delta t$ - the number of competencies in the synchronization mode at all levels (elements) of the future HUB, where Δt is the time interval for the synchronization of competencies of all levels (determined from the project success conditions:), t – project execution time.

Conclusions

1. The theoretical approach to the creation of a rational form of research & project area for the successful implementation of innovative projects is considered.
2. The methodology of creating IE entrepreneurial ecosystems is presented.
3. On the basis of the analogies principle a structural diagram and a mathematical model of the creation process and functioning of the corresponding innovative HUB in the form of coaxial elements around the center - an innovative idea - were developed.
4. Innovative HUBs can be considered as engineering and technical support for Start-up creation.

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