Business incubator assessment model

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Abstract. At the initial stage of economy innovative potential formation, the leading role belongs to small venture firms that provide market development of the intellectual activity results. Support for small businesses of this type is usually provided through the development of a business incubators system initiated by regional authorities and implemented through targeted budget funding. In this regard, it is important for incubators to develop an indicators system for evaluating the effectiveness of budget allocations and private investment. The paper proposes a two-level system of business incubator functioning and develops a management structure that allows analyzing the current state of the organization and the results of its work using a mathematical model. The incubator activity is determined by the state of the system at the time of starting the next cycle of work, the state of the incubated companies at each stage of incubation (pre-incubation, incubation, post-incubation) and planned tasks, taking into account resource and technological limitations. The proposed model can be used in the development of methods for continuous deviations monitoring from the planned performance indicators of the organization with the ability to pinpoint the problem and respond to it. The advantage of the proposed model is that it can be scaled up to the level of the innovation structure of the region.

1. Introduction
In today’s Russia, various measures are being developed and policies are adopted to promote economic development and increase the innovation potential of the economy. At the same time, the leaders in this context are small venture capital firms that facilitate market development of intellectual activity results. However, the majority of small firms are known to have failed and passed away, once got into the “valley of death” for various reasons of managerial, organizational and financial nature.

According to scientific articles [1, 2], business incubation programs for innovative companies enhance the survival rate of venture firms and reduce the number of unsuccessful innovation projects. Therefore, they have a significant role to play in the innovation infrastructure. Practical indicators of incubator performance in Russia do not allow us to draw any conclusions about how successfully the correspondent tasks are solved. This is primarily due to the lack of unified approaches to understanding the efficiency of infrastructure facilities, as well as the absence of a system of quantitative indicators that would provide such an assessment. In Russia, this becomes particularly important because the creation of business incubators is usually initiated by state authorities or
universities. Accordingly, their business model often implies targeted financing from the founders [3], i.e. budget financing. That is why the issues of effective use of these funds seem to be exceptionally relevant.

2. Theoretical framework

According to the definition of the state fund of funds and a development institute “Russian Venture Company” (hereinafter referred to as RVC) [4-6], a business incubator is an organization established to support entrepreneurs at an early stage of their business (under 3 years of activity). This organization shall offer premises for rent and provide services essential for business activities, including consulting, accounting and legal services. Statistics show that only 5% of all incubators in Russia are owned by individuals or companies, while the rest have been created and financed from the federal or regional budget.

The majority of business incubators are considered, on the one hand, as organizations for “nursing” fast-growing innovative companies and, on the other hand, as an instrument of economic development that promotes the spread of innovations, job creation, as well as the business realization of intellectual activity in the scientific sector. The main services of the business incubator include generating employment and infrastructure, creating educational programs and expert consulting, as well as assistance in team building, PR, and preparation for market entry (including foreign markets).

There are different business models and sources of income for incubators. As mentioned above, most of them are formed on the initiative of state authorities and budgetary educational institutions, so the main source of income for them is funding from stakeholders. In addition, the following sources of income can be singled out: rent for the use of premises and equipment, consulting services to residents, payment for educational and incubation programs, payment for services to attract financing.

As a rule, the specifics of a business incubator imply that only business units that have achieved certain success may become residents. As noted by Russian and foreign researchers [1, 5-9], the ultimate goal of the incubation process is boosting the survival rate of the incubated company and transforming the startup into a successful stable business.

3. Statement of the problem

In this regard, the main purpose of this work is to form a system of performance indicators for business incubators, which can be used by management bodies of the business incubators in assessing their activities and the efficiency of the use of budgetary allocations and private investments.

4. Methodology

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5. Discussion

5.1. Approaches to evaluate the efficiency of the incubators.

A considerable amount of scientific works is devoted to the issues of evaluation of business incubators’ performance. Given the budget nature of financing Russian incubators, the most remarkable are the requirements for their efficiency on the part of the authorities. For example, the Ministry of Finance has developed methodological recommendations to the executive authorities of the constituent entities of the Russian Federation and local governments, which help to increase the revenue base of the budgets of the constituent entities of Russia and municipal units in the country (8). Among other measures, this document states the need for constant evaluation of the effectiveness of the innovative economic infrastructure components. The recommended methodology is based on periodic surveys aimed at collecting quantitative and qualitative information about both the infrastructure facilities themselves and their residents. The following areas are suggested for analysis: human capital, organizational structure and economic contribution. Meanwhile, specific performance indicators are supposed to be set at regional levels of management independently (Figure 1).
These indicators have a recommendatory character and can be used by executive authorities of the constituent entities of the Russian Federation and local authorities both for comparative assessment of various business incubators and for studying the dynamics of a particular object development. Thus, within the state task of the Krasnoyarsk Regional Innovation and Technology Business Incubator (hereinafter referred to as KRITBI) for 2019 and for the planning period of 2020-2021, the Ministry of Economy and Regional Development of Krasnoyarsk Krai sets the following targets, which determine the quality and efficiency of KRITBI activities by main types of services and works performed (Table 1)[10-11].

![Image of indicators of business incubator efficiency]

**Figure 1.** Indicators of business incubator efficiency.

| Data on rendered state services |  |  |
|--------------------------------|-------------------|-------------------|
| Indicator characterizing the content of the state service | Quality indicator of the state service | Amount indicator of the state service |
| Provision of information and consulting support to small and medium-sized businesses | | |
| Providing services for the development of business plans, concepts, technical and economic specifications and investment projects to be implemented in a particular constituent entity of the Russian Federation | Satisfaction indicator of the service recipients, % | Number of small business enterprises which got the service |
| Preparation of presentation and information materials on the activities of small businesses for mass media and for publications | Satisfaction indicator of the service recipients, % | Number of small business enterprises which got the service |

| Data on works being performed |  |  |
|--------------------------------|-------------------|-------------------|
| Indicator characterizing the content of the work | Indicator of the work quality | Indicator of the work amount |
As can be seen from Table 1, for evaluating the quality of work and services provided they use metrics to assess the incubator’s efficiency in its key area of activity. However, these metrics do not take into account output criteria of incubator residents, and, accordingly, cannot assert that the main purpose of incubation has been achieved. Besides, the main criteria include the results of the incubator’s economic activity on a par with the indicators of incubation of innovative projects, which seems incorrect.

Also of interest are the results of research and quality analysis of business incubators and accelerators in Russia, conducted in 2017 by UBI Global on behalf of RVC and the Business Incubator of the National Research University “Higher School of Economics” (HSE {Inc}) [12]. According to this study, the key performance indicators of business incubators can be presented in three enlarged groups of criteria: value for ecosystem, value for clients, and attractiveness of programmes (Figure 2).

The main advantage of this methodology is that it takes into consideration a wide range of indicators recognized and used by many incubators in Russia and abroad. Therewithal, the methodology provides for the assignment of a weighting factor to each key performance indicator that reflects the relative importance of the respective indicator, which was not born in view in KRITBI.

Although the methodology covers a wide range of incubator performance indicators and is intuitive and easy to implement, we can but highlight its significant limitations:
- due to differences in the sectoral specialization of business incubators, it is not possible to create a universal system of weighting criteria under this methodology;
- due to the relatively young age of some business incubators and incubation programs, as well as their current and former residents, it may be difficult to collect information on all the above criteria.

Therefore, despite all the advantages of this methodology, it cannot be considered the only true and universal one.

Another approach for assessing the performance of the business incubator is presented in [13]. From the author’s point of view, the system of evaluation indicators concerning business incubator performance consists of three enlarged groups: indicators of the business incubator development, indicators of the residents’ development, and indicators of the business incubator’s impact on residents’ development. The main indicators in the above three areas are shown in Figure 3.

**Figure 3.** Indicators of business incubators’ performance and effectiveness / efficiency.

As the author remarks, each of the indicators presented in Figure 3 can be characterized by one or more numerical values, but these parameters are specific only for incubators established at universities, so this methodology seems very narrow and specialized.

In the foreign literature, the main performance indicators of business incubators are usually divided into following levels of activity: pre-incubation, incubation as it is, and post-incubation (after graduation from incubation). For example, paper [14] presents the author’s methodology, which allows for the assessment of incubator performance at all three incubation stages by so-called “hard” (quantifiable) and “soft” (non-quantifiable) criteria (Figure 4). According to this approach, the business incubator’s performance is evaluated by the progress of incubated companies, so the main performance indicators are reduced to mere assessment of residents at these three stages.
Another approach described in [15] implies a complex system of performance indicators (Figure 5), consisting of two enlarged groups: internal indicators of the business incubator itself (14 categories of indicators in total), and indicators of incubated companies, which in turn are divided into two groups: indicators of the company at the “input” level of the incubation program, and at the “output” level. Such elaborate system of indicators expedites evaluating the efficiency of the incubator as an infrastructure facility from the point of view of its main function, i.e. increasing the survival of companies. Nevertheless, this system is very complicated in terms of monitoring and collecting values. Besides, the work [16] does not offer a methodology for obtaining the final efficiency value for the listed indicators.
In general, it is possible to deduce that due to significant differences between Russian and foreign innovation infrastructure, as well as differences in legislation and regulation of innovation activities, orientation towards foreign experience may be but limited due to differences in the environment in which business incubators operate.

5.2. Two-tier business incubator model.

The process of incubating as regards innovation projects can be presented as a two-tier model, consisting of a management body and a set of business incubators at the lower tier. The interaction between the tiers is characterized by the degree of centralization of management, the degree of separation concerning the financial flow and the extent of isolation.

Figures 6 and 7 are structural diagrams of the two-tier model with distinct variants of relationships between the levels. These models can be used for business incubators with diverse types of management. The autonomy of business incubators lies in their ability to independently determine their specialization, prices for their services, order and methods of work with projects.

In a model with a high level of centralization (Figure 2), business incubators serve only as executors of orders coming from the managing body, which distributes them among business incubators according to the preset specializations.
The result of the two-tier model is innovative products and technologies that have already been brought to market and which are beginning to generate revenue. Simultaneously, this model also fits into the chain of commercialization with the possibility of subsequent transfer of the innovation project to the corresponding object of innovative infrastructure.

The managing body defines the main criteria for efficiency and direction of business incubators, moreover, within its competence it monitors and adjusts the works of the lower tier. In general, the managing body performs the following functions:

- determination of targets and goals of business incubators for the planned period, including explicitation of their specialization;
- allocation of financing, or making advance payments for planned tasks;
- allocation of available resources and provision of access to equipment;
- situational management;
- development and management of a system aimed at motivating and stimulating business incubators;
- distribution of incoming innovative projects and companies by directions according to the specialization of business incubators.

Business incubators, in turn, work with innovative projects and companies that select and commercialize innovations to generate new sources of income by getting a share in the incubated companies. Further we are going to examine innovative projects and companies as applications for the business incubator. The process of functioning of each business incubator is usually broken down into 3 stages [16-18]:

**Figure 6.** The model of interaction for business incubators with high autonomy.

**Figure 7.** Model of interaction with a high level of centralization at the level of managing body.
- pre-incubation. This stage includes the initial selection of incoming applications from innovative companies or teams and the determination of criteria for this selection;
- incubation. At this stage, the main work is done with innovative companies to commercialize innovations and generate income from them;
- post-incubation. This is a final stage of work with innovative companies, which involves steps to transfer the company to another object of innovative infrastructure or to establish the company’s foothold in the market.

However, this approach does not take into consideration the preparatory stage of the next cycle for a business incubator and the stage of efficiency assessment of the current cycle at its completion, which, accordingly, does not form an integral part of the system of the incubators’ performance indicators. This reduces the possibility of assessing the efficiency of the next cycle of the business incubator shorn of information at the beginning and end of the cycle.

5.3. Mathematical model of the business incubator state.

Functioning of business incubators can be effective only in case of a systemic approach to their management. For this purpose, the authors have designed a system of indicators for evaluating business incubators, which takes into account the two-tier model of their functioning. At any time business incubator’s activity is calculated by 1) the state of the system at the moment when the next work cycle starts, 2) the state of incubated companies at each stage (pre-incubation, incubation, post-incubation) and 3) compliance with the planned tasks (given resource-related and technological limitations). The overall state of each business incubator can be presented as following:

\[
A = F(f_0(t_0), f_1(X_1(t), X_2(t), X_3(t)), f_2(r, a, t))
\]  

(1)

where \(f_0(t_0)\) – a vector of indicators characterizing the state of the business incubator at the beginning of \(t_0\) – the period under review,

\(f_1\) – a vector of indicators characterizing the incubation of companies at the time \(t\) during the pre-incubation stage \(X_1\), incubation stage \(X_2\), post-incubation stage \(X_3\),

\(f_2\) – a vector of indicators characterizing the implementation of the planned tasks \(r\) aimed at commercialization of innovations with available resources \(a\) at the moment \(t\).

As for the set of indicators \(f_0\), let us take the following in general cases (Table 2).

| Indicator | Procedure of calculation | Designation |
|-----------|--------------------------|-------------|
| 1 Autonomy (Ability to independently determine specialization, prices for the services, order and methods of work with projects) | \(P_1 \times 30\% + P_2 \times 40\% + P_3 \times 30\%\) | \(P_1\) – Separate character of business incubator \(P_2\) – Self-determination in decision-making for functioning of the business incubator \(P_3\) – Self-organization of the business incubator (ability to develop owing to internal potential) |
| 1.1 Separate character (Level of internal supply as regards equipment, technology, etc.) | \((1 - \frac{\sum A_{com}}{\sum A}) \times 60\% + (1 - \frac{\sum L_{com}}{\sum L}) \times 40\%\) | \(A_{com}\) – An asset of the business incubator which is shared with another company \(A\) – An asset of the business incubator itself \(L_{com}\) – Liabilities of the business incubator which are shared with another company \(L\) – Liabilities of the business incubator |
| Indicator | Procedure of calculation | Designation |
|-----------|--------------------------|-------------|
| 1.2 Self-determination (Level of independent decision-making capability) | $\left(1 - \frac{F_{st} + F_{in}}{F}\right) \times 30\% + \left(\frac{\sum s I_{of} - \sum s I_{st}}{R}\right) \times 70\%$ | F – Total number of founders<br> F<sub>st</sub> – Founders from state enterprises<br> F<sub>in</sub> – Founders from large industrial companies<br> s – Number of startups which got investment<br> I – Total amount of investment in startups<br> I<sub>of</sub> – Sum of investment in startups at the expense of the own funds<br> I<sub>p</sub> – Sum of private investment in startups<br> I<sub>st</sub> – Sum of state investment in startups<br> R – revenue from the business incubator |
| 1.3 Self-organization (Internal growth level of the business incubator) | $\frac{CO}{CO + CB}$ | CO – Number of projects formed from within<br> CB – Number of projects introduced from outside |
| 2 Level of development of organizational communications contributing to the informative value of interaction | $\left(\frac{CM - CM_r}{n * (n - 1)}\right) \times 30\% + \frac{\sum c TC}{\sum c TW} \times 25\% + \frac{CI}{CI_r} \times 15\% + ST \times 10\% + LL \times 20\%$ | CM – Number of existing communication channels between the business incubator and innovative infrastructure facilities<br> CM<sub>r</sub> – Number of repetitive channels of communication<br> n – Number of participants in the process of communication<br> TC – Time spent on communication process in providing services to 1 client<br> c – Client<br> TW – Time spent on the work with one client<br> CI – Amount of works on collection and analysis of information<br> CI<sub>r</sub> – Amount of works on collection and analysis of information on identical (repetitive) topics<br> ST – Speed of transfer and spread of information<br> LL – Level of information loss |
| Indicator | Procedure of calculation | Designation |
|-----------|-------------------------|-------------|
| 3 Level of demand for services contributing to development | \[ \frac{O_{\text{R&D}} + O_D}{O_{\text{total}}} \times 60\% + \frac{P_{\text{sold}}}{P_{\text{got}}} \times 40\% \] | \( O_{\text{total}} \) – Total number of orders for research and development from private sector, \( O_{\text{R&D}} \) – Total number of orders for research and development from private sector, \( O_D \) – Total number of orders for development works from private sector, \( P_{\text{sold}} \) – Number of patents sold through the business incubator, \( P_{\text{got}} \) – Number of patents sold through the business incubator |
| 4 Level of engagement with academia and the private sector | \( \frac{P_j}{N} \times 65\% + \frac{E_{\text{sc}}}{RS} \times 35\% \) | \( P_j \) – Number of joint projects, \( N \) – Total number of new small innovative enterprises, \( E_{\text{sc}} \) – Share of research scientists employed in small innovative enterprises, \( RS \) – Optimum share of research scientists employed in small innovative enterprises (it is determined by the business incubator according to the directions of projects) |
| 5 Share of private financing R&D | \( \frac{\text{Ir&d}_{\text{depart}} + \text{Ir&d}_{\text{sc}}}{\text{Ir&d}} \) | \( \text{Ir&d}_{\text{depart}} \) – Sum of private investment in R&D departments, \( \text{Ir&d}_{\text{sc}} \) – Sum of private investment in R&D departments of scientific institutes, \( \text{Ir&d} \) – Total sum of investment in R&D, including grants |
| 6 Efficiency of the network uniting business incubator’s enterprises | \( \frac{\text{NP}}{N} \times 25\% + \frac{\text{PA}}{\text{NP}} \times 50\% + \frac{\text{JE}}{\text{NP}} \times 15\% + \frac{\text{S}_{\text{free}}}{S} \times 10\% \) | \( \text{PA} \) – Number of partner agreements, \( \text{NP} \) – Number of network participants, \( \text{JE} \) – Количество совместных предприятий (number of joint enterprises), \( \text{S}_{\text{free}} \) – Number of free services within the network, \( S \) – Number of services provided within the network, \( N \) – Number of newly registered small innovative enterprises |
| 7 Availability of access to private investors | \( (\text{NET} \times 40\% + \text{SI} \times 60\%) \times (\text{D} \times 70\% + \frac{\text{B}}{\text{N}} \times 30\%) \) | \( \text{NET} \) – Net present value of startups, \( \text{SI} \) – Satisfaction with the investments’ security, \( \text{B} \) – Number of investors in the database, \( \text{D} \) – Number of agreements on investment, \( \text{N} \) – Number of startups which need investment |
### Indicator

| Indicator | Procedure of calculation | Designation |
|-----------|--------------------------|-------------|
| 7.1 Net present value of startups | \( \sum_{i} NPV \) | NPV – Net present value of startups of \( i \)-startup |
| 7.2 Satisfaction with investment security | \( \frac{\sum_{i} I}{N} \) | \( I \) – Opinion of the \( i \)-investor asked \( N \) – Number of investors asked |
| 8 Efficiency of IP commercialization | \[ \frac{IP_c}{IP_b - IP_s} \times 65\% + \frac{IP_s}{IP_b - IP_c} \times 35\% \] | \( IP_c \) – Number of commercialized objects of intellectual property (IP) \( IP_s \) – Number of commercialized objects of intellectual property sold \( IP_b \) – Number of commercialized objects of intellectual property which were created with the help of the business incubator |
| 9 Efficiency of the allocation of the business incubator’s own funds | \( \frac{I_1 + I_2 + I_3}{N} \) | \( I_1 \) – Sum of preferable terms for incubation \( I_2 \) – Sum of direct investments \( I_3 \) – Sum of indirect investments (grants, competition, etc.) \( N \) – Revenue of enterprises which got financing |

As for the indicators characterizing the work on incubation of companies, it may be preferrable to use the previously considered indicators (Figures 6 and 7). They include general economic indicators and the results of technological audit.

Planned tasks for the business incubator stand for a plan for the number of commercialized products and technologies at a given time period, as well as the revenue of the business incubator, the number of activities carried out, etc. At the same time, the orientation of the projects the business incubator works with is not constant and can change during its work.

Planned targets may be achievable with sufficient resources and may be unachievable with their absence. In this case, this group of indicators can be presented as below:

\[
f_2(r, a) = \begin{cases} f_2^+, r | r(a) \neq \emptyset \\ f_2^-, r | r(a) = \emptyset \end{cases}
\]

(2)

In the first case, the business incubator is able to fulfill all the planned tasks with resources available, so the task becomes optimizational one entailing search for the most effective way of implementation against the background of abundant and overlapping planned tasks and possible results (the available resources).
resources are undoubtedly counted). In case of lack of resources for full implementation of planned tasks, the solution is to identify the minimum distance between \( r \) and \( r(a) \). Thus, to manage the business incubator it is feasible to determine the set of planned values \( A \) in accordance with the number of planned periods. At the end of each period, the deviations for each of the components are analyzed and corrective measures are developed. In order to achieve a single numerical value of deviation from the plan for each of the components and individual indicators, we quantify weight coefficients pursuant to the strategy and development priorities of the specific business incubator.

6. Conclusion
The following results were obtained following the work done:
1. There was built a two-tier model of business incubator functioning. A simple structure of this model enables analysis of business incubator’s work and it can be easily integrated into a more complex model, for example, the model for work of the innovation infrastructure as a whole. The proposed model can be of avail in studying both private and public business incubators and those run by universities.
2. A mathematical model has been made to describe the current state of the business incubator. This model can be applied to develop methods for continuous monitoring of business incubator activity and increasing the speed of response to deviations from the plan with the possibility of point solution of a particular problem.

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