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Developing Methodological Fundamentals of Criterial and Diagnostic Assessment of Idea Management Efficiency at an Early Stage of Innovative Process and Innovation Development in Higher Education Institutions on the Base of Screening Models and Innovation Ranking

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Abstract

Background/Objectives: The main goal of the research is development of methodology of criterial assessment of idea management efficiency and development of innovation at an early stage of innovative process as the basis for creating an instrument of information support for idea management and innovation development ensuring economy modernization and enhancing competitiveness among the Russian Federation subjects in the context of higher education institutions. **Methods/Statistical analysis:** To evaluate individual indicators of efficiency, we used rating method which is in full compliance with IREG principles, the mathematic model of which was approbated earlier when evaluating efficiency of educational institutions in Tambov region and the method of expert survey. To assess the costs we applied the method of substitution, replacement cost method, and initial cost method. To detect expected revenues from intellectual property we used the method of Discounted Cash Flow (DCF), direct capitalization method and residual revenue method. **Findings:** The results of our study on the base of screening models and innovation rating allowed us identify performing algorithms and criterial instruments providing the process of evaluating idea and innovation effectiveness at all stages of innovative activity: from idea generating to their commercialization and building a developed business with a high level of financial stability. Methodical and consulting support for introducing the system of informative support and innovation management with regard to industry features of each Russian Federation subject is the area for further application of the results of the study. **Applications/Improvements:** The results of the study will be used at the further stages of the project "Development of the instrument providing informative support for idea management and innovation development leading to economy modernization and competitiveness raise among the Russian Federation subjects within higher education institutions" as methodological and technologic foundation for designing informative system and its further testing in Russian higher education institutions.

Keywords: Commercialization of Intellectual Activity Results, Fundamental Research Potential, Innovations in Higher Education Institutions, Idea Management, Innovation Development

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1. Introduction

Characteristic feature of modern world economic development is transition of the leading countries to a new stage of forming innovative society – establishing economy based predominantly on generation, distribution and use of new knowledge. Production intensification and use of new scientific and technological results influenced sharp decrease of innovative cycle, boost in product and technology innovations[1]. At the same time, we observe that evaluation of efficiency of idea management and development of innovations in order to reduce investment risks on all stages of innovation activity is becoming more important.

One of the world trends of science and technology development is enhancing support and concentration of scientific research carried out in higher education institutions which are a core of integrated scientific educational complex, which is responsible for a major share of fundamental and applied researches[1] and thus enables transformation of ideas into innovations. Complexity and uncertainty of obtained results assessment predetermines the need for developing criterial and diagnostic instrument for evaluating efficiency of innovative activity in higher education institutions, and small innovation enterprises at each stage of research and development in order to intensify innovative activity in general and to detect synergetic effect.

Analysis of international and national experience in the level of the topic scientific development for evaluating efficiency of innovative activity in higher education institutions, and small innovation enterprises and other knowledge-based enterprises and organizations revealed:

- Characteristic features, benefits and shortcomings of realizing different models of innovative process;
- Factors influencing the process of idea transformation into innovative projects on the base of innovation life cycle;
- Major restrictions, shortcomings and extensive nature of traditional organization models, methods and ways of support and evaluation of innovative activity;
- Contradictions between the need for direct evaluation of idea management efficiency and not adequate theoretical and methodological concerning this issue.

Thus, the object of the research is development of criterial and diagnostic instrument for evaluating idea management efficiency at an early stage of innovative process and development of innovations in higher education institutions and defining of the conditions for synergetic effect.

Moreover, obtained results enabled us to define more accurately the object of the research: those processes and algorithms of managing ideas and innovations, which ensure intensification of innovation activity in a higher education institution:

(i) Evaluating efficiency of idea management at an early stage of innovative activity (Figure 1) which includes the following processes:

- Formalizing the idea;
- Author's technologic evaluation;
- Expert technologic audit of the idea;
- Selection of ideas;

(ii) Evaluation of efficiency of research and development (innovations) management (Figure 2) which includes the following processes:

- Evaluating fundamental research efficiency;
- Evaluating applied research efficiency;
- Evaluating research and development efficiency;

(iii) Evaluating efficiency of innovation commercialization management (Figure 3) which includes the following processes:

- Data gathering;
- Determine costs for complete reproduction of intellectual property (IP);
- Determine expected profits from IP;
- Comparative analysis of cost and income approach;
- Evaluate efficiency of internal use of IP;
- Evaluate efficiency of external use of IP.

2. Literature Review

Clearly, innovation management as any other type of management should include constant evaluation of efficiency of activity and the result obtained at different stages. The research showed that historically the first model of innovative process was the model of "technology or science push" (around 1950-s). Later 5 generations of innovative process models changes. As a result a concept of open innovations appeared.

Today methodology of describing and evaluating innovations under conditions of market economy is based on international standards. To coordinate the work on gathering, processing and analysing information about science and innovations within the Organization for Economic Cooperation and Development (OECD), a group of experts on science and technology indicators has been established which developed Frascati Manual, 2002. Regularly, the provisions in the Manual are amended due to the changes in the strategy of science and technological policy on the national and international levels and due to changes in organization of scientific research and development. In one of the latest revisions of Frascati Manual there are main definitions concerning research and development, their structure and limits as well as the methods for measuring the number of personnel in research and development.

The method of gathering data on technological innovations is based on the guidelines approved in Oslo (Norway) in 1992. It was named Oslo Manual, 2005. Oslo Manual, a joint publication of OECD and Eurostat, is guidelines on gathering and interpretation of data about innovations. This is the main reference document to determine innovations from the point of view of statistics and it underlies innovation research in the whole world.

In 2005 the Commission of the European Communities (CEC) developed a system of indicators for assessing innovative activity on macro-level which is applied for evaluating the development of innovative activity in the member countries of the European Union and their comparison against the USA and Japanese indicators[2].

CEC system of indicators is constantly reviewed and improved. Initially the system included 20 indicators divided into 4 groups:

- Human resources (5 indicators);
- Generation of new knowledge (4 indicators);
- Transfer and use of knowledge (4 indicators);
- Financing of innovations, results of innovative activity (7 indicators).

The benefit of CEC indicators is their classification by stages of innovative activity: input indicators, indicators of innovative process (business activity) as well as outcome innovative indicators. CEC indicators are integrated into a compound indicator: Summary Innovation Index (SII) which is a brief evaluation of innovative activity of a country. SII is calculated for all the countries using available indicators the number of which varies between 12 and 29 depending on a country[2].

The model Stage-Gate proposed by R. Cooper was popular to manage innovations on micro-level. This model is a consistent management plan for creating product innovation from idea to product launch. Currently, the model is extended by the methodology of managing portfolios for innovation monitoring and evaluation of their efficiency as well as for implementing enterprise strategy and mission[3].

The screening of innovative products and especially ideas at early stages of their development is one of the most important management tasks which are explained by a great amount of investments in innovations. Currently, the model "Funnel" proposed by Steven Wheelwright and Kim Clark is used for screening innovative ideas. This model is a sequence of innovative process filtration competing with one another to obtain resources and is based on strategic aims of a manufacturing enterprise and its technological and financial potential[4].

It is a well-known fact that "efficiency" can be interpreted as a relative effect, efficiency of the system, production activity of an object, project or a program. In quantitative terms efficiency is defined as attitude, actual (expected) result (effect) towards the costs needed to obtain it. Thus, the main elements constituting efficiency is, on the one hand, obtained result and on the other hand – costs and spent resources due to which it is obtained. Comparing these two elements we are able to evaluate efficiency or make our judgments about it when result cannot be expressed in monetary terms. As a result resource-market approach was developed to evaluate innovative activity which enables us to consider innovative activity in the context of forming competitive strategy in a corporation. More detailed analysis of innovative activity resources and corporation competencies, their active use regarding industry competition factors will allow to avoid making a wrong choice in terms of competition strategy as research of innovative activity of corporation should begin with evaluation of its potential. Different researchers proposed various lists of company resources, which help organizations to obtain their competitive advantage. Among resource classifications within resource concept classification by R. Grant is worth mentioning. According to it, resources can be divided into material (physical assets and financial resources), immaterial resources (brands, trademarks, reputation etc.), human (production services offered by people to a company in the form of their skills, knowledge, abilities)[5].

To evaluate economic efficiency we used such indicators as Return on Investment (ROI), Return on Assets (ROA), Internal Rate of Return (IRR) and others. But the main problem we faced is how to separate all costs and revenues regarding research and development and a certain project. A number of studies show that ROI indicator can be used only for short-term and clearly defined projects[6].

3. Methods

To evaluate individual indicators of efficiency, we used rating method which is in full compliance with IREG principles, the mathematic model of which was approbated earlier when evaluating efficiency of educational institutions in Tambov region[7] and the method of expert survey[8].

To assess the costs we applied the method of substitution, replacement cost method, and initial cost method[9].

To detect expected revenues from intellectual property we used the method of discounted cash flow (DCF)[10], direct capitalization method[11] and residual revenue method[12].

When assessing efficiency of intellectual property the following basic methodology was used[13]:

- Principle of economic efficiency of intellectual property means that the growth rate of intellectual capital return should be faster than those of costs needed for its creation.
- Benefit principle. Only the objects of evaluation which are able to satisfy certain demands may have value under condition that they are used during a certain period of time;
- Principle of supply and demand. The value of the object of evaluation depends on supply and demand on the market and on the character of competition between sellers and buyers;
- Principle of substitution. The value of the object of evaluation cannot be greater than the most probable expenses on purchasing the object of equivalent value;
- Principle of expectations. The value of the object of evaluation depends on the expected size, duration and probability of obtaining revenue (profits) which may be obtained during a certain period of time under condition of its efficient use;
- Principle of change. The value of the object of evaluation changes with time and is defined as of specific date;
- Principle of external influence. The value of the object of evaluation depends on external factors defining conditions of their use, for example, specified by market infrastructure, international and national legislation, state policy concerning intellectual property, ability and degree of legal defense etc.;
- Principle of the most efficient use. The value of intellectual property is defined according to the most

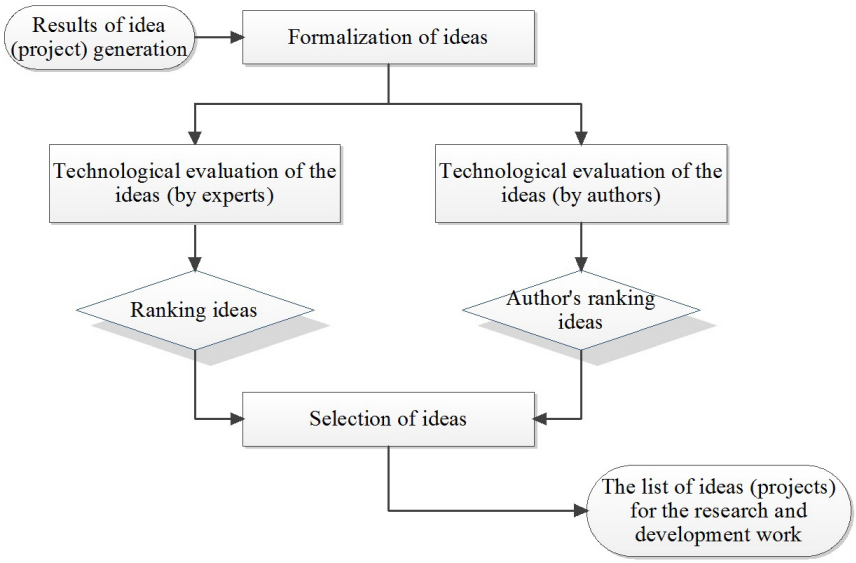

Figure 1. Algorithm of evaluating efficiency of idea management at an early stage of innovative process.

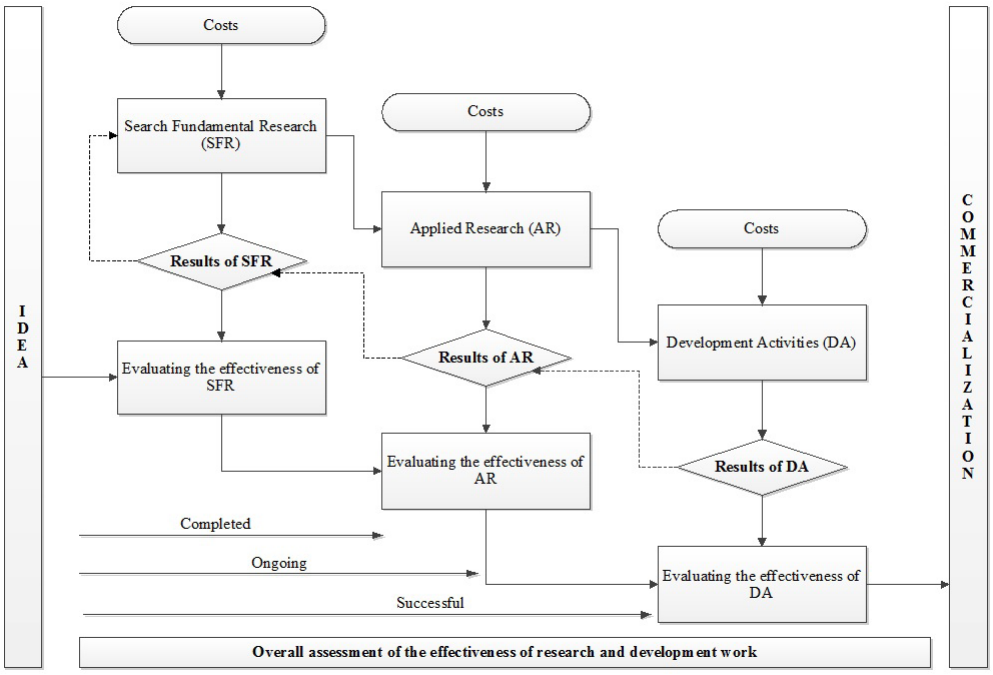

Figure 2. Algorithm of evaluating research and development efficiency.

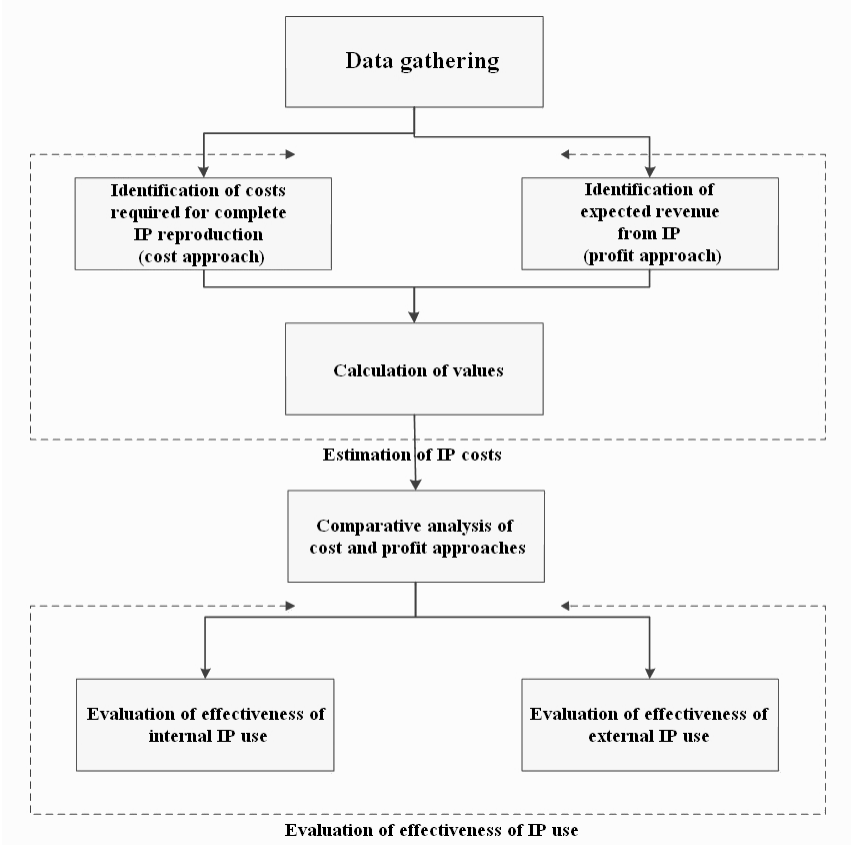

Figure 3. Algorithm of evaluating the use of intellectual property.

probable use of intellectual property which is viable, economically feasible, in line with legislation requirements, financially practical and in the result of which estimated value of intellectual property will be highest possible.

4. Results

4.1 Criterial and Diagnostic Evaluation of Idea Management Efficiency at an Early Stage of Innovative Process

At the stage of Idea Formalization the author (team of authors) creates the Passport (feasibility study) of the idea which includes the following sections:

- Rationale for the selected idea;
- Rationale for the need to develop given innovative project for large technologies;
- Identification of opportunity to transform the idea into a material form (new product) salable on the market;
- Analysis and selection of the market for entering the market with the innovation;
- Explanation of the time when innovation will enter the market;
- Calculation of costs for innovation production and implementation;
- Calculation of efficiency of innovation production and implementation;
- Calculation of general economic efficiency of the innovative product (profitability) including: integral effect, profitability index, profitability rate, time to benefit (Table 1).

At the stage of Author technical evaluation of the idea for assessing its commercial potential and implementing success, it is necessary to study the following aspects:

- Authorship;
- Patent search;

Table 1. Indicators of general economic efficiency of the innovative product

Criteria/Indicator	Description of the indicator
1. Integral effect (E_t)	Integral effect is measured by discount coefficient which is always less than one as otherwise the money today would cost less than tomorrow. Discount coefficient is calculated by the following equation: $E_t = \frac{1}{(1+i)^{t-t_p}}$ where, i is interest rate expressed as a decimal fraction (discount standard); t_p is a year of levelling cost benefits (accounting year); t is a year when cost benefits are brought in line with accounting year. Discount coefficient is always less than one with positive standard value of the interest on the capital i.
2. Profitability index (J_R)	Profitability index is a ration of given revenues and innovation expenses given on the same date and it is calculated by the following equation: $J_R = \frac{\sum_{t=0}^{t_p} D_j \times E_t}{\sum_{t=0}^{t_p} K_j \times E_t}$ where, J_R is profitability index; D_j is revenue during the period j; K_t is teh size of investments within the period t.

	The equation contains in its numerator the amount of revenue by the time the innovation was first implemented, and in denominator – the amount of investments in innovations discounted by the moment of the first investment. This reflects two parts of payment flow: profitable and investment. Profitability index is closely connected with the integral effect. If integral effect E_{int} is positive, then profitability index $J_R > 1$ and vice versa. With $J_R > 1$ innovative project is considered to be economically feasible. Otherwise, ($J_R < 1$) the project is not efficient. Under condition of tight shortage of funds, preference should be given to innovative solutions with the highest profitability index.
3. Profitability rate (E_p)	Profitability rate E_p is the rate of discount with which the amount of discounted revenue for a certain number of years becomes equal to innovations. In this case revenues and costs of innovative project are calculated by the following equation: $D = \sum_{t=1}^{t_p} \frac{D_t}{(1+E_p)^t}$, и $K = \sum_{t=1}^{t_p} \frac{K_t}{(1+E_p)^t}$ For further analysis innovative projects are selected internal rate of revenue of which is not less than 15-20%. Estimated value E_p is compared with the rate of return required by the investor. Investment decision may be taken into consideration if the value of E_p is not less than the value demanded by the investor. If innovative project is financed only by bank loans, then the value of E_p indicates the upper limit of the allowable level of bank interest rate. If the limit is higher, the project is economically inefficient. When the project is financed by other sources as well, then the low limit of E_p is in line with the price of advanced capital which may be calculated as weighted average rate of payments for the use of advanced capital.
4. Time to benefit (T_o)	Time to benefit is calculated by the following equation: $T_o = \frac{K}{D}$, where: K is initial investments into innovation; D is annual cash revenue (the sum of annual depreciation and annual net profit). If annual profit is not uniform, then the payback time is equal to the period (the number of years) during which total net cash payments exceed the value of investments. In general, the payback period n is equal to the time period: $\sum_{k=1}^{n} P_k > Inv$, where, $P_к$ is net cash profit during a year k due to investments and is calculated as a sum of annual depreciation during the year k and annual net profit for the year k; *In v* is amount of investments.

- Feasibility check;
- Ideas (technologies) identification for reference;
- Identification of market benefits of the technology;
- Assessment of market perspectives;
- Practical feasibility.

Criteria and indicators for assessing commercialization potential success of idea implementation by the authors (team of authors) are given in Table 2[14-17].

Author technological idea evaluation should result in author ideas rating.

Table 2. Criteria and indicators for assessing commercialization potential success of idea implementation

Criteria/Indicator	Weighing coefficient	Points				
		0	1	2	3	4
Technical feasibility of the concept	0,1					
Reliability of the concept is not confirmed		X				
The concept is confirmed by expert findings			X			
The concept is confirmed by calculations				X		
The concept has been tested in practice					X	
Operability of the product has been tested under real conditions						X
Market benefits	**0,3**					
Many analogues on a small market		X				
Few analogues on a small market			X			
Several analogues on a big market				X		
One analogue on a big market					X	
The product does not have analogues on a big market						X
Product price is much higher than the price of analogues		X				
Product price is not much higher than the price of analogues			X			
Product price is almost equal to the price of analogues				X		
Product price is not much lower than the price of analogues					X	
Product price is much lower than the price of analogues						X
Technical and consumer qualities of the product are inferior to the ones of analogues		X				
Technical and consumer qualities of the product are a bit worse than the ones of analogues			X			
Technical and consumer qualities of the product are equal to the ones of analogues				X		
Technical and consumer qualities of the product are a bit better than the ones of analogues					X	
Technical and consumer qualities of the product are much better than the ones of analogues						X
Operating expenses are much higher than in analogues		X				
Operating expenses are a bit higher than in analogues			X			
Operating expenses are equal to the analogues				X		
Operating expenses are a bit lower than in analogues					X	
Operating expenses are much lower than in analogues						X
Market perspectives	**0,4**					
The market is small and does not have positive dynamics		X				
The market is small and does have positive dynamics			X			
Middle market with positive dynamics				X		
A big stable market					X	
A big market with positive dynamics						X
Active competition between large companies on the market		X				
Active competition			X			
Moderate competition				X		

Table 2. Criteria and indicators for assessing commercialization potential success of idea implementation

Criteria/Indicator	Weighing coefficient	Points				
		0	1	2	3	4
Technical feasibility of the concept	0,1					
Reliability of the concept is not confirmed		X				
Insignificant competition					X	
Lack of competition						X
Practical feasibility	**0,2**					
Lack of specialists to implement the idea both from technical and commercial point of view		X				
There is need to hire specialists or spend significant material and time resources for training existing employees			X			
There is need to provide employees with minor training and increase personnel				X		
There is need to provide employees with minor training					X	
There are specialists to implement the idea both from technical and commercial point of view						X
To implement the idea there is need in significant financial resources; there are no sources of financing		X				
Insignificant financial resources are required; there are no sources of financing			X			
Significant financial resources are required; there are sources of financing				X		
Insignificant financial resources are required; there are sources of financing					X	
Additional financing is not required						X
To implement the idea development of new materials is needed		X				
Materials used in military industrial sector are required			X			
Expensive materials are required				X		
Materials for implementing the idea are cheap and available					X	
There are all the necessary materials for implementing the idea						X
Period for idea commercialization is extremely long		X				
Much time for idea commercialization is required			X			
Little time for idea commercialization is required; long period for return on investment				X		
Little time for idea commercialization is required; medium period for return on investment					X	
Little time for idea commercialization is required; short period for return on investment						X
Elaboration of development documents for product production and implementation is required		X				
There is need in obtaining many approvals for product production and implementation that requires significant time and material expenses			X			
Procedure for obtaining approvals for does not require much time and money				X		
Notification of regulatory bodies for product production and implementation is required					X	
Regulatory restrictions on product production and implementation are absent						X

The model for building author ideas rating should be based on comparison of the evaluation results for each separate idea in accordance with given criteria and on creating integral estimate.

The main characteristic feature of this approach is that low value of the estimate with one criteria and indicator block may be compensated by high estimate with another criteria. This enables us to take into account to the greatest possible extent the potential of commercialization and success of idea implementation.

The author ideas rating is calculated with the following Equation (1):

$$R(I) = \sum_i \left[\left(u_i \times \sum_j X_j(I) \right) \right] \quad (1)$$

where $R(I)$ is final author idea rating,

u_i is weighted coefficients characterizing the degree of influence of i-th criteria on point value of the indicator; weighted coefficients in this case meet the condition (2)

$$\sum_i u_i = 1,\ u_i \in [0, 1] \quad (2)$$

X_j is point value of the indicator for assessing potential of commercialization and success of implementing each idea.

At the stage of expert technologic idea audit, expert evaluation should be based on the analysis of scientific content of the project and scientific potential of the author or team of authors. When analyzing scientific content of the projects, the following aspects are considered:

- Clear presentation of the project conception;
- Clear goal setting and selection of research methods;
- Qualitative characteristics of the project: does the project have: fundamental character; interdisciplinary or systemic character; applied character;
- Scientific base (for example, there is substantial scientific and methodological base for solving the problem formulated in the project; publications on the topic; scientific and methodological elaboration of the problem is absent);
- Novelty in problem setting (for example, the author formulated and scientifically justified research problem for the first time; the author proposed original approaches to solving the problem; research problem formulated in the project is well known to the scientific community and the author has not proposed original approaches for solving the problem).

At the *first stage* of expertise it is necessary to:

- Select the ideas in accordance with the results of the author technological idea audit;
- Designate 2-3 independent experts for each idea.
- проведенотборидейнаосноверезультатовав торск оготехнологическогоаудитаидей; factors preventing objective expertise should be taken into account. It may be the case with the "conflict of interests": the project is at odds with scientific interests of the expert; the expert had (has) partner, financial, kin relations with the project manager (implementers); provides scientific guidance to the project manager (implementers); provides scientific guidance to the project manager (one of the main implementers).

At the *second stage* the experts should build rating for each idea.

Rating is calculated by the following Equation (3).

$$R = r_1 + r_2 + r_3 + r_4, \quad (3)$$

Where R is the total idea rating,

r_1 is coefficient considering the content and scientific value of the project:

- Clear presentation of the project conception and business idea (clear – 1, not clear – 0);
- Clear goal setting and selection of research methods(clear – 1, not clear – 0);
- Technical merit and feasibility (realistic– 1,not realistic – 0);
- Technical level (modern with perspectives – 2, modern – 1, lower than modern – 0);
- Scientific base (there is substantial scientific and methodological base for solving the problem formulated in the project– 2, publications on the topic – 1, научно-методическаяпроработкапроблемыо scientific and methodological elaboration of the problem is absent– 0);
- Novelty (the problem was formulated for the first time – 2, original approach to solving the problem – 1, formulated problems are well known – 0);

Coefficient $r_1$evaluates the probability that implementation of the project will lead to fundamentally new

results, provide substantial advance in the chosen area and have impact on the progress in this or allied fields. For instance, $r_1 = 5$ may mean "relative use of the project", $r_1 = 9$ "bid to an outstanding result", $r_1 = 2$ "the project is not perspective".

r_2 is coefficient identifying potential of the team of authors and if it is real to carry put the project in time:

- Adequate qualification and experience of the project participants (adequate – 1, not adequate - 0);
- Completeness of the team (corresponds to the project objectives – 1, does not correspond to the project objectives – 0);
- Project feasibility by efforts of the authors team (project participants are able to perform the work – 1, expert has doubts whether the authors will be able to perform the work– 0).

r_3 is coefficient for evaluating initial situation:

- Working area (there is proper working area – 1, there is no proper working area - 0);
- Initial financing (there is initial financing – 1, there is no initial financing - 0);
- Contract partners (there are contract partners – 1, there are no contract partners - 0).

r_4 is coefficient characterizing market perspectives of the project:

- Effective demand for the product (available – 1, not available – 0);
- Competitors, market duplication (available – 1, not available – 0);
- Prospects for further development of the sector (available – 1, not available – 0).

At the *third stage* the experts need to detect the most attractive ideas (projects) form the point of view of expenses – idea potential.

Evaluation is based on two methods: "cost - effectiveness" and "expenses - profit". The methods use two-criteria assessment: ratio of total profit (effectiveness) to total expenses (costs) for identifying the revenue per cost unit.

At the second stage the experts assess idea potential in the form of R – total rating for each idea (project), as total estimate of different coefficients: $R = r_1 + r_2 + r_3 + r_4$,.

For each idea (project) k required costs C_k have been calculated. Thus we can calculate the ratio characterizing expected value of effectiveness per cost unit:

$$Ef_k = R_k/C_k, \quad (4)$$

where:

R_k is idea potential;

C_k costs on its implementation.

Placing the projects in descending order of the ratio R_k/C_k, we obtain the rating of ideas (projects) by the level of their preference, taking into account that the most preferable project is the project with the greatest expected effectiveness per cost unit.

The second preferable project is the project having the second big value of expected effectiveness per cost unit etc.

To create project portfolio having the greatest expected effectiveness, we need to gradually include other projects in descending order of the ratio R_k/C_k unit l allocated funds are exhausted. The example is given in the Table 3.

If the projects included into the list in accordance with the aforementioned algorithm exhaust all the allocated funds, then we obtain the optimal solution for resource allocation problem. Otherwise, we will need to consider additionally potentially the most efficient use of what is left from the allocated funds.

The result of expert technological audit is expert idea rating.

The model of building expert idea rating should be based on comparison between the results of the ration of each idea effectiveness per cost unit.

At the stage of idea selection the Expert council provides its opinion concerning the idea (project) and set of projects following the results of the following works:

Table 3. Data by indicators

Indicator	Ideas (projects)			Amount of expenses for realization	Total amount of allocated funds
	1	2	N		
Idea potential (R_k)					
Expenses for realization (million. rubles), C_k,					
Effectiveness per cost unit (Ef_k.)					

- Authors technological assessment of the idea;
- Expert technological audit of the idea.

Each expert participating in the council must fill in an inquiry form explaining his opinion. Expert report is formalized as answers to the questions and includes the following options of expert's final conclusion:

- 5 – Idea (project) deserves unreserved support;
- 4 – Idea (project) deserves support;
- 3 – Idea (project) may be supported;
- 2 – Idea (project) does not deserve support;
- 1 – Idea (project) does not deserve consideration by the Expert council.

The results of the inquiry are summarized and the members of the Expert council adopt a joint decision concerning including the idea (project) into the program (plan) of research and RandD works.

4.2 Criterial and Diagnostic Assessment of Efficiency of Research and Development and practical Value of Obtained Results in Terms of their Commercialization

Criterial and diagnostic assessment of efficiency of research and development and practical value of obtained results in terms of their commercialization should be done when each stage of research and development is complete: at the stage of fundamental research, applied research and R and D. It is due to the fact that there are three "critical" points in performing R and D when we need effective coordination and assessment of obtained results – a move from science to project development, from project development to new product design. Each stage of translating information into knowledge is characterized by different degree of alienability, legal protection and commercial value (Table 4).

Every type of activity (stage) of research and development involves the following processes:

- Collection and data record of fundamental research.
- Expert review of research results
- Fundamental research rating
- Selection of research

4.2.1 Assessment of Effectiveness of Fundamental (Basic) R and D

Objective: at the stage of assessing effectiveness of fundamental R and D, we need to identify potential of fundamental (basic) researches. Assessment of commercial potential of fundamental research (FR) at the stage of expertise is performed by building the following multiplicative model[13]:

$$CP_{ia} = V_f \times P_{suc} \times P_o \quad (5)$$

Where CP_{ia} is the level of commercial potential of FR;
V_f, is factual relevance of FR;
P_{suc} is probability of commercial success;
P_o level of alienability of FR.

Assessment of factual relevance of FR is performed by calculating the coefficient of obtained result, the coefficient of complexity of solved technical task and the coefficient of novelty:

$$V_f = K_r \times K_d \times K_n , \quad (6)$$

Where V_f, is factual relevance;
K_r is coefficient of obtained result:
K_d is coefficient of complexity of solved technical task;
K_n is coefficient of novelty.
It is reasonable to use the following values of the mentioned coefficients (Tables 5-7)

Table 4. Characteristics of research and development and the level of alienability of obtained knowledge

Activity	Characteristics	Level of alienability	Commercial value
Fundamental RandD	New theoretical knowledge, fundamental concepts	Extremely low	Extremely low
Fundamental (basic) RandD	Methods of practical knowledge application	Low	Extremely low
Applied RandD	Knowledge relating to certain new product or technology	Medium	Low
Research and design	Knowledge embodied in technical documentation and in development models	Relatively high	Medium

Table 5. Coefficients of obtained result

Degree of achieving planned technical characteristics	Coefficient of obtained result
Actual achievement of secondary technical characteristics which are not defining for this product (technological process).	0,2
Actual achievement of technical characteristics confirmed in writing (in acts, layouts etc.).	0,3
Actual achievement of technical characteristics which are defining for a certain product (technological process) confirmed in writing.	0,4
Actual achievement of qualitatively new major technical characteristics of the product (technological process) confirmed in writing.	0,6
Actual acquisition of a new product (technological process) having good main technical characteristics among other well-known types of the same product.	0,8
Actual acquisition of a new product (technological process) for the first time implemented into production and having qualitatively new major technical characteristics.	0,9

Table 6. Coefficients of complexity of the solved technical task

Technical task solution	Coefficient of complexity of solved technical task
Technical task is solved by constructive completion of one simple standard element, one process operation	0,1
Technical task is solved by constructive completion of a complex element, changing two or more secondary parameters of simple processes or operations of the technological process	0,2
Technical task is solved by constructive completion of one major or several secondary elements, processes	0,3
Technical task is solved by constructive completion of several major elements, processes	0,4
Technical task is solved by constructive completion of all elements, processes	0,7
Technical task is solved by constructive completion of all elements, processes with complex related systems, complex technological systems	0,8
Technical task is solved by constructive completion of technological processes, mainly related to new fields in science and technology	0,9

Table 7. Coefficients of novelty

Degree of technical solution novelty	Coefficient of novelty
The task is solved with the help of an invention enabling new use of well-known tools (when the formula starts with the word "application")	0,2
The task is solved with the help of an invention which is a new set of well-known solutions enabling achievement of a technical result, i.e. when characterizing portion of the formula contains references to new relations between well-known elements, different sequence of operations etc.	0,3
The task is solved with the help of an invention having a prototype which is in accord to majority of characteristics of a new solution	0,5
The task is solved with the help of an invention having a prototype which is in accord to half main characteristics of a new solution	0,7
The task is solved with the help of an invention having a prototype which is in accord to a fewer number of main characteristics of a new solution	0,8
The task is solved with the help of an invention which is characterized by a set of significant differences not having a prototype, i.e. when an invention solves new or unknown problem by principally new approaches	0,9

Table 8. Coefficients of commercial success

Ratio of planned and actual terms for implementing the project	Coefficient of commercial success
P_{suc}<**1**	**0,1**
P_{suc}≈**1**	0,3
1 <$\mathbf{P_{suc}}$< 1,5	0,6
$\mathbf{P_{suc}}$> 1,5	0,9

Assessment of probability of commercial success is performed with regard to the assumption that the faster the project will be implemented the higher probability of success. Thus, probability of commercial success is calculated by the following equation:

$$P_{suc} = \frac{T_{pr}}{T_{fact}}, \quad (7)$$

where P_{suc} is the probability of commercial success of FR;

T_{fact}, is actual time spent on FR development;

T_{pr} *is the term of implementing the project, documented in the plans for the final result.*

Considering the value of commercial success probability, we identify the coefficient of commercial success (Table 8).

Assessment of alienability degree of the FR results by its creators is performed considering the degree of factual alienability (Table 9).

Then we need to compare commercial potential of FR with cost dynamics.

Table 9. Indicators of alienability degree of the FR results by its creators

Alienability degree of the FR results	Indicator of alienability degree of the FR results, Po
Zero (on the level of one person idea)	0,1
Idea of two or more specialists	0,3
Черновая документация (drafts, layouts)	0,4
Approved technical specification	0,5
Approved design documents	0,75
Prototype model	0,8
Report on the testing results	0,9

After completion of this work rating of fundamental research is expected to be built. The model for rating building should be based on comparing results of scientific potential evaluation in accordance with the given criteria and on forming integral estimate.

The main characteristic feature of this approach is that low value of the estimate of one criteria and one block of indicators may be compensated by the higher estimate for another criterion. This allows taking into account scientific potential of the research.

Rating of scientific potential of the research is calculated by the following equation (8):

$$R(Np) = \sum_i \left[\left(u_i \times \sum_j X_j(Np) \right) \right] \quad (8)$$

Where $R(Np)$ is the final rating

u_i is weighted coefficients characterizing the degree of influence of the *i*-th criteria on indicator value; weighted coefficients satisfy (4)

$$\sum_i u_i = 1,\ u_i \in [0,1] \quad (9)$$

X_j is indicator's value of scientific potential assessment for each research.

Using the rating results it is reasonable to introduce the following clustering:

- The most attractive;
- Attractive;
- Less attractive.

In the context of the process for selecting researches, the expert council gives the expert opinion about the research and set of researches with regard to the expertise results.

Each expert participating in the council must fill in an inquiry form explaining his opinion. Expert report is formalized as answers to the questions and includes the following options of expert's final conclusion:

- 5 – Idea (project) deserves unreserved support;
- 4 – Idea (project) deserves support;
- 3 – Idea (project) may be supported;
- 2 – Idea (project) does not deserve support;
- 1 – Idea (project) does not deserve consideration by the Expert council.

The results of the inquiry are summarized and the members of the Expert council adopt a joint decision:

- About completing the research (it is reasonable to complete the research, low efficiency);
- About continuing the research (it is reasonable to continue the research, high efficiency);
- About successful research (the research is successfully completed, expected result is achieved and may be used for further commercialization).

4.2.2 Assessment of Effectiveness of Applied R and D (AR)

Objective: at the stage of assessing effectiveness of applied R and D we need to identify a potential of scientific and technical results of applied researches.

Reviewing the results of applied researches, the experts should give their estimated by the following criteria:

- Prospectives of using the results;
- Scale of implementing the results;
- Completion of the results.

Criteria system is given in Table 10.

Then we need to calculate the coefficient of science and technical efficiency of applied R and D which is calculated by the following Equation (10):

$$Kp = \sum_{i=1}^{k} Kf_i \times Kc_i \qquad (10)$$

where, k is the number of evaluated parameters;

Kf_i is the coefficient of influence of the i-th parameter on science and technical efficiency of applied R and D;

Table 10. Criteria and the system of indicators for evaluating effectiveness of applied research

Criterion	Weighted coefficient	Indicator	Indicator characteristic	Coefficient of attained level
Prospectives of using the results	0,5	High-priority	Result may be applied in many scientific areas	1,0
		Important	Result may be applied in developing new technical solutions	0,8
		Useful	Result may be applied in further R and D	0,5
Scale of implementing the results	0,3	National economy	Time for realization: Up to 3 years Up to 5 years Up to 10 years Over 10 years	 1,0 0,8 0,6 0,4
		Industry	Time for realization: Up to 3 years Up to 5 years Up to 10 years Over 10 years	 0,8 0,7 0,5 0,3
		Companies and enterprises	Time for realization: Up to 3 years Up to 5 years Up to 10 years Over 10 years	 0,4 0,3 0,2 0,1
Completion of the results	0,2	High	Technical specifications for development and design OKP	1
		Medium	Guidelines, detailed analysis, suggestions	0,6
		Insufficient	Review, information	0,4

Kc_i is the coefficient of relative increase of the *i*-th parameter against reference value.

Selection of researches is performed by the method described in the section 2.1.

4.2.3 Assessment of Effectiveness of Research and Design

Objective: at the stage of assessing effectiveness of research and design, we need to evaluate their technical and economic effectiveness.

The system of criteria and indicators for assessing technical and economic effectiveness of research and design is given in Table 11.

Selection of researches is performed by the method described in the section 2.1.

4.3 Criterial and Diagnostic Assessment of Effectiveness of using Intellectual Property

At the stage of data gathering we need to gather qualitative and quantitative indicators required for:

- Evaluating intellectual property cost;
- Evaluating effectiveness of using intellectual property.

At the stage of evaluating intellectual property cost, the following sequence of actions is applied:

Table 11. The system of criteria and indicators for assessing technical and economic effectiveness of research and design

Criterion	Indicator
Technical and economic effectiveness	Consumption cost serves as an integral economic indicator of a new product (innovation) in comparison with its analogue. It is expressed by the following formula: $I_C = K+Z,$ where, K is non recurrent capital expenditures (for purchasing, transportation, assembling and associated costs); Z expenses on operation and maintenance during the period of using the product. Complete equation for identifying integral economic indicator is: $I_C = K+Z+Y_{sum} - P_C,$ where Y_{sum} is the total sum damage caused by abandonment; P_C associated positive results from using the new product. Integral technical indicator of the product's analogue: $I_n = \prod_{i=1}^{n} A_i^{g_i}$ where, g_i is a weighted coefficient of the new product characteristic; A_i – analogue of the new product; Integral technical indicator of the new product: $I'_n = \prod_{i=1}^{n} A_{i}^{(='g\bar{i}}$ where, A_i' is a new product. Technical and economic effectiveness is calculated for the product's analogues and new products by the following equation: $\prod_{i=1}^{n} A_i^{g_i} / I_C$ и $\left(\prod_{i=1}^{n} A_{i}^{(='g\bar{i}}\right) / I'_C$

Relative technical and economic effectiveness	Relative technical and economic effectiveness is calculated by the following formula: $\frac{\prod_{i=1}^{n} A_i^{g_i} / I_C}{\left(\prod_{i=1}^{n} A_{i_i^{(='g_i)}}\right) / I_C'}$

(i) Identification of costs needed for Intellectual Property (IP) reproduction (cost approach). In the context of this work, we need to identify the cost of IP by calculating the costs required for creating or purchasing, protecting, producing and implementing intellectual property at the date of evaluation.

(ii) Identification of expected revenues from IP (Discounted Cash Flow method or DCF, direct capitalization method and method of residual revenue). In the context of this work, we need to identify benefits of expected (potential) revenues from using IP. Future benefits mean future net revenue (a share of money flow of a higher education institution or a company) from using IP. This revenue should be regarded as a cash flow resulted from using IP. Forecast period is defined as a total period of economic lifetime of IP, date of its creation and date of cost evaluation. Forecasting cash flows, it is necessary to clearly define the date of receiving revenue (evenly throughout the period, at the beginning or at the end of the period) and take this allowance into account when discounting cash flows (for example, assuming even cash flows throughout the period, it is necessary to perform discounting mid-way through the period).

(iiii) Cash flow forecasting generated by intellectual property. The cost of asset is identified on the base of net cost of future cash flows generated by it. Consequently, we need forecast about sales volume by using intellectual property under our evaluation, operating profit, actual amount of paid taxes and net investments in working capital and permanent assets. It is important to take into account not only sales with intellectual property under evaluation but real economic effect generated by using intellectual property. According to methodological guidelines of the Russian Federation Chamber of Commerce and Industry, it is reasonable to use the method for calculating the discount rate proposed by the Decree of the Russian Federation government #1470 dated 22.11.1997 (as amended by the Russian Federation Decisions dated 20.05.1998 # 467 and 03.09.1998 # 1024).

At the stage of comparative analysis of cost and profit approach with regard to obtained results, we compare amount and dynamics of IP relying on two methods, including:

- Cost of IP;
- Change of cost of IP during the accounting period in comparison with the data form the previous period;
- Absolute and relative deviation in IP cost.

The stage of evaluating effectiveness of using IP depends on the type of its use: internal or external.

Criteria and the system of evaluating indicators of effectiveness of using IP are given in Tables 12 and 13[13].

5. Discussion

The obtained results were discussed during the meeting of Science and Technical Council of the group of companies IBS and the acceptance commission of the Russian Federation Ministry of Education and Science approved these results.

The novelty of evaluating algorithm for idea management at an early stage of innovative process includes integration of authors and expert idea audit from the point of view overcoming positive and negative aspects, i.e. authors estimate.

The authors for the first time proposed an approach combining the authors estimate (self-estimate) and expert audit. A complex approach enables us to compensate inaccuracies of the authors evaluation on the one hand and compensate expert evaluation of the idea, on the other hand, based on the previous experience of the experts, author self-estimate and with regard to the novelty and the depth of understanding the proposed idea.

Table 12. Criteria and the system of evaluating indicators of effectiveness of external IP use

Criterion/Indicator	Calculating method
Return on capital	Ratio of balance and net profit to the average cost of IP
Efficiency in using licenses (know how) (E)	$E = \sum_{t=0}^{T} \frac{R_t - S_t}{(1+r)}$ where, R_t is cost estimate of the result of using licensed technology during a year t; S_t expenses related to the use of licensed technology during a year t; r discount rate; T period of using a license (know how).
Efficiency (profitability) in using IP under a license E_i	$E_i = \Delta D_i = N_i[(Ts_n - C_n) - (Ts_D - C_D)]$, where ΔD_i is additional profit gained by the licensee in the result of using licensed IP during the year i; N_i volume of production generated with the use of IP under a license during the year i; Ts_n, C_n price and production cost after using a license; Ts_D, C_D price and production cost after using a license.

Table 13. Criteria and the system of evaluating indicators of effectiveness of internal IP use

Criterion/Indicator	Calculating method
Turnover	Ratio of revenue from sales of products with the use of IP for a certain period of time to the balance cost of IP for the same period.
Return on sales	Ratio of gross profits generated by the sales of products with the use of IP to the revenue from sales of products with the use of IP.
Engagement in economic turnover (Profitability (D_{ois}))	$D_{ois} = K \times R$ where, K is a coefficient of commercial impact from using IP; R return on sales. Coefficient of commercial impact from using IP (K) is the ratio of return on sales generated by using IP to the average cost of IP in a company.

Moreover, it was proposed for the first time to evaluate the results of the main stages of research and development from the point of view of their alienability, but not only final results of research and development. This approach will allow evaluate practical value of obtained results from the point of view of their commercialization.

The novelty of the method is in integrating two approaches for identifying the costs: cost approach and profit approach which makes evaluation more objective.

6. Conclusions

The results of our study on the base of screening models and innovation rating allowed us identify performing algorithms and criterial instruments providing the process of evaluating idea and innovation effectiveness at all stages of innovative activity: from idea generating to their commercialization and building a developed business with a high level of financial stability.

Methodical and consulting support for introducing the system of informative support and innovation management with regard to industry features of each Russian Federation subject is the area for further application of the results of the study.

The results of the study will be used at the further stages of the project "Development of the instrument providing informative support for idea management and innovation development leading to economy modernization

and competitiveness raise among the Russian Federation subjects within higher education institutions" as methodological and technologic foundation for designing informative system and its further testing in Russian higher education institutions.

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