Innovation Risks in the Region — Expert Analysis

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Abstract—**The article presents the analysis of expert opinions on the degree of risks influence and risk events probability in the process of business innovative activity. The subject of the research is Voronezh region, the region with the average for the Russian Federation level of innovative development. The heads of enterprise units, which implement innovative projects, the employees of relevant departments and innovation agencies of Voronezh region served as experts for the research. The results of expert assessment were processed through fuzzy sets method, which allowed tracing the high level of expert opinions consistency. It was found that most risks have low value both in terms of the degree of influence and risk events probability. Market risks are most significant for investment activity, while institutional risks are least prominent.**

Keywords—innovative activities; innovative project; innovation risk; expert assessment

I. INTRODUCTION

The innovative path of the Russian economy is currently one of the priorities of the country's social and economic development. The Russian regions are extremely differentiated by indicators of the innovative development: number of the innovatively active enterprises; number of designed and implemented advanced production technologies; number of researchers, including those with academic degrees, student population, etc. [1], [2], [3]

The researchers and the practitioners usually associate insufficient level of innovative activities with high risks of innovative activities, changes in economic environment, small business development level and other factors. [4], [5], [6], [7], [8]

However, the concept of "risk" implies the possibility of most various causes of its emergence. Besides, the opinions of the researchers differ substantially in relation to the degree of impact of the risk and the probability of their occurrence. Therefore, we have set the objective of conducting the expert assessment of risks for innovative processes in Voronezh Region, the region with the medium level, as concerns the Russian Federation, of innovative development.

II. METHODICAL APPROACH TO ASSESSING THE INNOVATION RISKS IN THE REGION

We made the evaluation of innovation risks on the basis of the expert opinions. The experts were represented by senior managers of the enterprises performing the innovative activities, executive officials and innovative development agencies of Voronezh Region. In total 26 experts participated in the expert survey.

Altogether the experts defined 24 risks relating to various areas of socio-economic life. All risks, stated by the experts, were divided into five groups: technical and technological risks; market risks; financing risks and risks associated with organization of financial activities; human resource risks; institutional risks. Initially, there was no division of risks into groups, so as to avoid the involuntary bias of the experts' assessment caused by formulating a conventional name for each group.

The evaluation was made with regard to probability and risk impact strength separately. The probability in this case was evaluated not in the traditional range of 0 to 1.0. The said distribution of probabilities is accepted for the repeatable processes. The process that we have been analyzing does not involve repetitions. That is why the choice of range may vary. We have taken the range of one of the traditionally used evaluations, from 0 to 5. This range is easily understandable for the experts and allows us to evaluate any process within the range of fuzzy assessments from: non-significant (0) to highly significant (5).

In our study, the experts were offered to assess the risks according to the following scale: 0, no risk; 1, possibility of risk, minimum degree of gravity; 2, possibility of risk, low degree of gravity; 3, possibility of risk, average degree of gravity; 4, possibility of risk, high degree of gravity; 5, possibility of risk, critical degree of gravity.

To estimate coherence of the experts' opinions in this case, aggregation of results with account of the mean values of the strength of impact, the probability of occurrence of the event and the fuzziness indices for each risk was performed using formula 1:

$$Ojo = \frac{\overline{Lim} \times \overline{Ljm}}{1 + Ljfs \times Ljpo} \qquad (1)$$

Ojo is the summarizing indicator of the probability and the degree of impact of the risk;

$\overline{Lmfs}$ is the mean value of the evaluations of the risk impact strength;

$\overline{Lmpo}$ is the mean value of the evaluations of the probability of occurrence of the risk event;

Ljfs is the fuzziness index of the evaluations of the event impact strength;

Ljfs is the fuzziness index of the evaluations of the probability of the event;

While taking into account various approaches towards calculation of the coherence indicators based on fuzzy sets method, the analysis of the corresponding theoretical works has been made. The fuzzy sets method was employed following the works of L. Konysheva, D. Nazarov [9], [10]. The methodical approach of the said authors is simple enough to use and is successfully applied in researches of the regional socio-economical processes. [11]

For the final evaluation of the degree of impact of the risks and the probability of their occurrence, it is considered that their mean values for none of the risks have not taken values 0 or 1. Consequently, the usage of the five-point scale is inappropriate. For the total evaluation a three-point scale is used: below 3 — low probability or degree of impact; from 3 to 4 — average, above 4 — high.

The summarizing indicator, as follows from formula 1, shows the combined impact of the probability and the degree of the risk gravity on its joint impact on the innovative processes. For the clear vision of the impact of a certain risk on the innovative processes, it must be taken into account, that the maximum value of the summarizing indicator (when maximum mark for the probability and the risk impact strength made by all experts is 5) equals 25.

Along with the ratio of summarizing indicators of the risks, the "risk evaluation index" indicator is employed showing the relation of each of them to the maximum value. The event risk evaluation index (the event is the occurrence of any given risk) shows its relation not to the greatest possible value, but to the actually obtained value. That is, the risk evaluation indices demonstrate their gravity and probability within the range of 0 to 1.0, where 1.0 is the maximum mark for the risk given by the experts with account for coherence of their opinions.

III. RESULTS OF ANALYZING THE INNOVATION RISK EVALUATION

The results of the performed analysis of the innovation risks are presented in "Tables I" to "Table V". "Table I" presents the results of evaluation for the group of technical and technological risks.

TABLE I.   EVALUATION OF TECHNICAL AND TECHNOLOGICAL INNOVATION RISKS

Technical and technological risks						
Risks	Mean values		Fuzziness indices		Summarizing indicator	Event risk evaluation index
	Probability of occurrence of a risk	Degree of gravity of a risk	Probability of occurrence of a risk	Degree of gravity of a risk		
1 Lack of necessary equipment	2.500	3.231	0.100	0.076	8.016	0.64
2 Downtime of equipment (failure, absence of tooling)	2.654	2.923	0.083	0.065	7.716	0.62
3 Production defects	2.800	2.880	0.091	0.120	7.977	0.64
4 Lack of component units and tools, disruptions of supplies	2.731	3.038	0.077	0.050	8.266	0.66
5 Loss of access to raw materials	1.962	3.346	0.050	0.067	6.542	0.52
6 Underestimation of the complexity of works and, as a consequence, impossibility of carrying out a conceived project to the full extent	3.115	3.846	0.095	0.065	11.909	0.95
7 Unavailability of qualified maintenance service	2.680	3.000	0.063	0.083	7.998	0.64
8 Environmental risks associated with development and implementation of innovative projects	2.269	2.846	0.083	0.133	6.388	0.51
Mean value for the group of technical and technological risks	2.589	3.139	Overall mean values in the group were not calculated			

As it can be seen from the data given in "Table I", technical and technological risks are assessed by the experts as low ones. The greater part of assessments is below three, that is, the risk evaluation can be considered as low one. In terms of probability of occurrence, only the risk of underestimation of the complexity of works is assessed as average. On the average the values of risk assessment are slightly above 2.5.

The gravity of consequences is assessed higher by the experts. Out of eight risks, five are considered as the medium-level risks. The average rating for the gravity of technical and technological risks is above three.

The experts' opinions are coherent enough, both in terms of assessing the probability of occurrence of the risks, and in terms of their gravity. Only in terms of the degree of probability of two risks — production defects and environmental risks — there are the differences of the experts' opinions exceeding 0.1.

The event risk evaluation index for "underestimation of the complexity of works" is 0.95, which is the highest index among all risks in this group.

The highest summarizing indicator of the event risk with account of the ambiguity of the experts' opinions is 11.909. The value is not very great, considering that the greatest possible evaluation of risk, when the experts' opinions are unambiguous, amounts to 25.

"Table II" presents the results of the experts' assessments of the market risks.

TABLE II.   ASSESSMENT OF MARKET-RELATED INNOVATION RISKS

Market risks						
Risks	**Mean values**		**Fuzziness indices**		**Summarizing indicator**	**Event risk evaluation index**
	Probability of occurrence of a risk	**Degree of gravity of a risk**	**Probability of occurrence of a risk**	**Degree of gravity of a risk**		
9 Overvaluation of sales market	3.308	3.577	0.076	0.071	11.768	0.94
10 Lack of demand for the products	3.077	4.077	0.067	0.056	12.498	1.0
11 Wrong assessment of competitors and their unpredictable strengthening	3.115	3.346	0.053	0.056	10.394	0.83
12 Release of a product with similar characteristics by another company	3.038	3.000	0.065	0.114	9.049	0.72
13 Appearance of developments at the market substituting your technologies	3.231	3.538	0.061	0.091	11.369	0.91
Mean value for the group of market risks	3.154	3.508	Overall mean values in the group were not calculated			

The data given in "Table II" let us state that the market risks are more crucial for the innovative activities than the technical and technological risks — all values exceed 3.0. And the assessment of the degree of gravity of the risk exceeds 4.0, although the probability of occurrence of this risk is rated slightly above 3.0. The experts consider the risk of market release of the products with similar characteristics to be the least threatening risk. In other words, the threat does not consist in competition with other innovators, but in lack of demand for the products as such.

On the average, the level of assessment of this group of risks is average, whereas the degree of gravity is higher, than the probability of occurrence of these risks.

The summarizing indicator for "lack of demand for the products" is the highest of all risks — the value is 12.498, evaluation index for the said risk is 1.0.

It must be noted that just as in the group of technical and technological risks, the coherence of the experts' opinions is rather high — the fuzziness indices, in general, do not exceed 0.1. The least coherent are the experts' opinions in relation to the degree of gravity of the release of the products by other production company — the fuzziness index is somewhat higher — 0.1.

"Table III" presents the results of the experts' assessment of the financing risks and risks associated with organization of financial activities.

Human resource risks are presented as a single indicator — "staff shortage/staff turnover," designated by number 19 in our list. The probability of occurrence of the risk and the degree of its impact are quite highly rated: 3.115 and 3.538, correspondingly. The fuzziness index for probability of occurrence of the risk is 0.046, for the degree of gravity — 0.083. In other words, the experts' opinion is rather coherent. The summarizing indicator of the risk is 10.981, evaluation index is high — 0.88.

Expert assessment of the group of institutional risks is presented in "Table IV".

TABLE III.   ASSESSMENT OF THE FINANCING RISKS AND RISKS ASSOCIATED WITH ORGANIZATION OF FINANCIAL ACTIVITIES

Financing risks and risks associated with organization of financial activities							
Risks		*Mean values*		*Fuzziness indices*		*Summarizing indicator*	*Event risk evaluation index*
		Probability of occurrence of a risk	*Degree of gravity of a risk*	*Probability of occurrence of a risk*	*Degree of gravity of a risk*		
14	Exchange market volatility and, as a consequence, increase of cost of imported equipment and component units	3.308	3.346	0.045	0.117	11.010	0.88
15	Increase of prices for source materials, electricity and water supply	3.308	2.654	0.114	0.100	8.679	0.69
16	Risks associated with the need for refunding due to violation of the financing conditions	2.923	3.808	0.091	0.083	11.046	0.88
17	Blocking of the company's settlement account at the commercial bank (even one with high rating) due to bankruptcy or rehabilitation	2.654	3.462	0.125	0.104	9.068	0.73
18	Legal, accounting risks associated with product commercialization	2.808	2.615	0.076	0.100	7.288	0.58
Mean value for the group of financing risks and risks associated with organization of financial activities		3.000	3.177	Overall mean values in the group were not calculated			

TABLE IV.   ASSESSMENT OF INSTITUTIONAL INNOVATION RISKS

Institutional risks							
Risks		*Mean values*		*Fuzziness indices*		*Summarizing indicator*	*Event risk evaluation index*
		Probability of occurrence of a risk	*Degree of gravity of a risk*	*Probability of occurrence of a risk*	*Degree of gravity of a risk*		
20	Difficulty of obtaining the protective documents (patents, statements, certificates, etc.)	2.923	3.000	0.111	0.083	8.689	0.70
21	Theft of invention, industrial espionage	2.346	2.846	0.077	0.083	6.635	0.53
22	Risks associated with the actions of regulatory bodies and authorities	3.000	3.115	0.107	0.056	9.291	0.74
23	Public protests connected with development and implementation of innovative projects (mineral extraction projects, nuclear projects, petrochemical projects, etc.)	2.308	3.077	0.125	0.095	7.017	0.56
24	Interference of external organizations in implementation of innovative project	2.692	2.731	0.095	0.117	7.271	0.58
Mean value for the group of institutional risks		2.654	2.954	Overall mean values in the group were not calculated			

Analyzing the data given in "Table IV" lets us state that, on the whole, the data are not very highly rated by the experts — both probability, and the degree of gravity of this group of risks are below 3.0.

The risks associated with the actions of regulatory bodies and authorities are the highest (average level of risk). The value of the summarizing indicator is slightly above 9.0; risk evaluation index is above 0.7, which can be deemed average in the aggregate of the risks.

The risk of theft of invention and industrial espionage is least pronounced — the summarizing indicator (0.53) is 22nd most crucial one in the overall suite of twenty four risks. Less rated by experts, although to a small extent, are only environmental risks and risks of loss of access to raw materials from the group of technical and technological risks (risk indices are 0.51 and 0.52, correspondingly). The probability of this risk is rated lower than the degree of its impact.

What draws attention is the strongly varying assessment of probability and strength of impact of the public protests connected with development of innovative projects — the probability is low, the strength of impact is average. Due to the low probability of this risk, the value of its summarizing indicator is slightly more than 7.0, and the evaluation index is 0.56 (one of the lowest among the risks of all groups).

The risks associated with obtaining patents, statements and other protective documents are assessed as low ones in terms of probability and average ones in terms of the strength of impact. However, the border between the assessments is purely indicative — the probability is 2.9, the gravity is 3.0. The value of the summarizing indicator is not very high (8.7), just as that of the risk index (0.7).

IV.   CONCLUSION

The performed study shows that the risks of innovative activities in Voronezh Region are slightly pronounced both

in terms of probability of occurrence of risk events, and in terms of the degree of their impact.

The values of the fuzziness indices demonstrate a strong coherence of the experts' opinions.

The risks of the market risk group are the highest, but they, too, fall within the average level, except for the degree of the gravity of the lack of demand for the products, which can be considered as high.

The experts assigned the average level of risk to the group of financing risk and risks associated with organization of financial activities. The highest of these risks are the risks associated with the need for refunding due to violation of financing conditions. Of considerable importance are the risks associated with blocking of the company's settlement account at the commercial bank (even one with high rating) due to bankruptcy or rehabilitation, as well as exchange market volatility and, as a consequence, rise in cost of imported equipment and component units.

The technical and technological risks are assessed as low ones in terms of probability and average ones in terms of the degree of impact on the innovative processes. The greatest impact may be caused by the underestimation of the complexity of works and, as a consequence, impossibility of carrying out an innovative project to the full extent.

Human resource risks fall in the average level of gravity.

Contrary to the popular perception of the unfavorable institutional environment in Russia and the country's regions, the institutional risks, on the whole, do not go beyond the low level both in terms of probability, and in terms of the degree of impact. The exceptions are the risks associated with the actions of regulatory bodies and authorities, which the experts consider as average ones.

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