Novi Ekonomist
Vol 15(2), Year XV, Issue 30, july - december 2021.
ISSN 1840-2313 (Print) 2566-333X (Online)
DOI: 10.7251/NOEEN2130107M

Submitted: 27.04.2021.
Accepted: 13.05.2021.
Short or preliminary report
UDK: 001.891:[005.334:658.5

DEVELOPMENT OF A METHODOLOGY FOR ASSESSING THE SCIENTIFIC AND TECHNOLOGICAL RISKS OF TECHNOLOGICAL INTEGRATION

Alexander Miller
Dostoevsky Omsk State University, Russia
aem55@yandex.ru

Alexey Davydov
Dostoevsky Omsk State University, Russia
da63277@yandex.ru

Paper presented at the 9th International Scientific Symposium „EkonBiz: Economy and COVID 19“, Bijeljina, 17 – 18th June 2021.

Abstract: *The aim of the study is to develop methodological assessment tools for assessing the scientific and technological risks of manufacturing enterprises technological integration. Key provisions of the theory of management, the theory of organization, and modern risk theories were chosen as fundamental research methods. The methodological basis was made up of instrumental, process, resource and matrix approaches. A wide range of research methods were used in the study: descriptive method, method of generalization and abstraction, method of classification and argumentation, and analytical and graphical method. The theoretical results of the study are the disclosure of key criteria that should comply with the methodology for assessing the scientific and technological risks of participants in technological integration. Theoretical justification of classification characteristics of scientific and technological risks is given, that allows to identify advantages of quantitative assessment of risk situation. The practical results of the study are analytical assessment of scientific and technological risks of technological integration of manufacturing enterprises, based on quantitative methods. A method of assessing scientific and technological risks is proposed, it will be based on the analysis of risk events in order to identify the possible amount of damage from the onset of these risk events and the likelihood of their occurrence. The advantages of the proposed methodology for quantifying scientific and technological risks related to the possibility of regulating the classification of risks available to participants in technological integration are justified. The classification of scientific and technological risks allows to expand the range of analyzed risks for the participants of technological integration, as well as to apply operational monitoring to identify new risk areas.*

Key words: *scientific and technological risks, technological integration, methodological approach, assessment, manufacturing industry*

1. INTRODUCTION

The risk management system for participants of technological integration can be considered as an independent project due to the versatility of its purpose. The strategic direction of manufacturing industries technological development often includes risk targeting as a measure of economic security. When certain trends of progressive development are replaced by the economic recession, the tools designed to counter the effects of crisis situations, including those based on minimizing risks, start playing the central stage. At present, manufacturing industries are mostly facing scientific and technological risks. These risks accompany particular businesses at all stages of technological integration when technological processes are deepening, new technologies are introduced, and existing technologies are improved. A distinctive feature of technological integration is the innovative cycle compression that occurs when we are creating new products and services. This compression arises due to the digitalization of the research process, as well as to the development of ways industrial enterprises and their stakeholders use to communicate. At the same time, as practice shows, the wider the possibilities and prospects of this integration process, the more likely is the occurrence of adverse events caused by existing gaps in the production management and research and development activities, as well as by difficult financial and economic situation. This serves as a basis for finding ways to minimize the scientific and technological risks of manufacturing enterprises technological integration. These enterprises usually have links with other market participants and organizations, therefore their risks and the risks of their stakeholders are of a common origin, although they differ in the specific methods of their assessment. The difficulties in assessing the scientific and technological risks of technological integration are rooted in the absence of a universal methodical assessment toolkit, since both economic theory and business practices link the ongoing organizational and structural changes to the management process only, excluding the need to assess the technological integration development.

2. THEORETICAL RESEARCH

Risk management issues have long been the outsiders in the field of theoretical economic research. This happened since the research concentrated at the level of static equilibrium models, which are more common at the macro level, while risk as a phenomenon is common for the particular economic entities. Also, the risk manifests itself in dynamic systems and thus is associated with changes and uncertainties. Another drawback of classical theories is the fact that the assessment of real risks was performed with a certain amount of subjectivity. In other words, there were neither quantitative methods of risk evaluation nor formalized methods for its optimization.

Marshall, the founder of the neoclassical theory of risk, researched the behavior of economic agents in the face of risk and uncertainty. The key stipulation of the neoclassical risk theory is as follows: when we are choosing an alternative of the economic entity activity, we are guided by two criteria, namely the size of the expected profit and the number of its possible fluctuations (Marshall, 1993, vol. 3, p. 23). Knight, who was the first to conclude that risk assessment was necessary, argued that "the risk in the business sphere should be assessed (if it is necessary at all) by bringing together the results available from experiments" (Knight, 1965, p. 209). A significant contribution to the development of risk theory was also made by John Maynard Keynes (Keynes, 2012, p. 132), John von Neumann (Neumann, Morgenstern, 1953) and Harry Markowitz (Markowitz, 1990).

Specialists and researchers consider the problem areas of integrating technologies at the level of economic entities from the point of view of developing unified rules for the production management, sales and services provision, as well as for the research activities. Each of these areas has more or less common and specific risks, with technological risks being crucial for technological integration (Chung, Kim, Lee, 2020, p. 422-437; Gong, 2020; Hao, Sun, Xie, 2020, p. 32-42; Hsu, Li, Bao, 2020; Susie, Noja, Cristea, 2020, p. 742-757; Tohanean, Buzatu, Baba, Georgescu, 2020, p. 758-774; Yang, Han, 2020, p. 71-94; Zhao, Huang, Wu, 2020).

Assessing existing theoretical approaches to research of risks in general, and scientific and technological risks in particular, one can conclude that when creating or organizing innovations, an economic entity faces uncertainty because there is no unambiguous variant of their outcome. The economic entity's idea of a positive outcome suggests setting a specified goal, which is to gain profit or to reach other positive effects. However, this uncertainty implies that further developments may be unfavorable and, consequently, no profit can be gained.

3. RESEARCH RESULTS

The developed methodology for an assessment of scientific and technological risks is based on quantitative methods of risk evaluation, and these are risk situations that should be assessed in the first place. This approach creates difficulty in determining the probability of a risk event, as basically all methods of determining it are based on expert methods of assessment. Here we suggest a method of assessment of the scientific and technological risks, which will be based on the necessity to analyze risk events to determine the possible damage caused by these risky events and the probability of their occurrence.

The risk situation can be measured quantitatively by multiplying the volume of profit or loss due to the implementation of a risky event by the probability of the risk situation. For each risky event, it is necessary to define the probability of its occurrence and the loss or profit. It is difficult to analyze the external environment of technological integration participants because it has a greater degree of uncertainty compared to an internal one. It is also extremely difficult to determine the probability of a risk situation. It is necessary to have macroeconomic information, as well as information about the products of foreign competitors and markets. Therefore, in the development of a methodology for assessing scientific and technological risks, it is advisable to take into consideration only internal factors that are most common for each participant of technological integration.

Talking about internal factors of scientific and technological risks and their risky events, the probability of their occurrence and damage indicators are more related to production and technology, as well as management, marketing, finance, innovation, and personnel.

Production usually faces the following risks:

1. The risk of non-compliance of contractual obligations and failure to meet the deadlines.

Failure to fully meet contractual obligations within specified time limits indicates that the participant of technological integration is an irresponsible counterparty. In the future, it causes a reduction in the volume of contracts or their complete termination. The volume of losses is measured according to the planned volume of contracts for the fiscal periods to follow; the probability of occurrence is the ratio of the number of failure preconditions to the number of contracts. To clarify the probability of this risky situation, it is necessary to analyze the statistical data of the participant of technological integration concerning the implementation of contracts over the past few years.

2. The risk of incomplete or limited production capacity

The first sign of incomplete production capacity is the excess of passive capital assets over the active ones, and its consequences are an increase in conditional-constant costs in the share of the original cost. This risk can be both permanent and temporary, i.e. associated with forced downtime due to various reasons. The constant incomplete production capacity can be caused by the presence of a large number of obsolete equipment, which is not used in the primary production process due to its moral wear and tear.

If the production capacity is constantly incomplete, the probability of occurrence equals 1, and the damage equals the number of costs associated with the maintenance of capital production assets that are not used in production.

It is different in the case of temporary incomplete production capacity.

Here, the probability of occurrence depends on the causes of the downtime. Basically, they include force majeure circumstances, such as power lines break downs. In this case, the probability of occurrence is low, and it is almost impossible to estimate it. The damage will equal the cost of restoring the performance of the technological integration participant, as well as the implicit costs, such as the volume of goods that are not manufactured due to the downtime.

In the context of production growth, the participants of technological integration can find out that their current production capacity is not enough. At the same time, if a participant of technological integration is aware of this incomplete production capacity, measures will be taken to eliminate it.

These measures can include purchasing the equipment, renting additional space or introducing measures to increase the effectiveness of the working time fund. Therefore, the probability of this risk will be connected with the probability of non-implementing these measures on time.

In table 1, you can find the dynamics of the capacity use ratio of Spektr, LLC.

In the light of the values presented in table 1, we can conclude that Spektr production capacity is constantly incomplete. Nevertheless, the dynamics of this indicator is positive, which indicates a gradual increase in the volume of manufactured goods.

Table 1. Dynamics of the capacity use ratio changing

Indicator	2018	2019	Growth rate, from 2018 to 2019	2020	Growth rate, from 2019 to 2020
Capacity use ratio, %	68.4	69.1	101.0	72.3	104.6

Source: Authors' research

3. Risk of lack of raw materials and supplies.

The necessary materials and equipment are usually delivered by suppliers with whom the technological integration participants have concluded relevant contracts. Therefore, when assessing the validity of the material management plan, it is necessary to have information on the number of contracts with suppliers that provide individual resources according to the company's needs.

Thus, based on the contracts and draft treaties, a material management plan has been drawn up according to the types of commodities and materials (C&M) (see table 2).

Table 2. Material management plan - 2020 for Spektr, LLC according to concluded contracts and draft treaties, thousand rubles.

Type of C&M	Delivery for the second quarter of 2020	Delivery for the third quarter of 2020	Delivery for the fourth quarter of 2020
Ferrous metals	1,168.75	1,058.45	1,265.98
Non-ferrous metals	4,524.54	4,367.54	5,412.75
Electrical materials	5,569.54	6,857.56	6,568.54
Chemicals	6,547.58	6,354.45	7,859.63
Tools and gear	5,547.41	7,016.85	6,458.14
Other C&M	9,872.10	9,548.54	7,412.55
Total	33,229.92	35,203.39	34,977.59

Source: Authors' research

According to the need for raw materials and supplies based on approved plans and material management plan, we determine the surplus of different types of raw materials and supplies in the structure by the end of the reporting quarters of 2020. As of March 31, 2020, the structure is based on the actual data of operational accounting. Thus, the expected surplus in the warehouses of Spektr, LLC in this structure by the end of the quarters (table 3) is as follows:

Table 3. Surplus of raw materials and supplies in the warehouses of Spektr, LLC, thousand rubles.

Type of C&M	Factual as of March 31, 2020	Planned as of June 30, 2020	Planned as of September 30, 2020	Planned as of December 31, 2020
Ferrous metals	2,604.65	2,742.97	2,759.74	2,983.00
Non-ferrous metals	14,209.52	14,439.86	14,741.54	14,465.77
Electrical materials	13,476.86	8,620.20	4,620.96	-210.68
Chemicals	20,299.98	19,433.22	19,571.60	19,304.51
Tools and gear	16,900.70	15,560.23	17,122.80	16,815.06
Other C&M	17,344.18	18,907.43	22,209.03	22,678.16
Total	84,907.89	79,703.91	81,025.67	76,035.82

Source: Authors' research

Based on tables 2 and 3, it is possible to determine the ratio of the number of contracts concluded for material resources of a particular type to need for them for Spektr, LLC. The normative value of this factor is ≥1. Thus, according to Table 4, Spektr, LLC has enough contracts for the supply of raw materials and supplies. This is due to the advanced purchase of goods and commodities for the production of basic goods considering the expected increase in the prices of imported equipment. A value of less than 1 in this ratio was formed in the fourth quarter of 2020 for electrical materials, which often become a deficit position. To eliminate this risky situation, measures are taken to meet the production needs of this type of material.

Table 4. The ratio of the number of contracts concluded for material resources of a particular type to need for them for Spektr, LLC

Type of C&M	Second quarter	Third quarter	Fourth quarter
Ferrous metals	3.66	3.65	3.86
Non-ferrous metals	4.36	4.63	3.54
Electrical materials	1.83	1.43	0.98
Chemicals	3.62	4.15	3.38
Tools and gear	3.26	4.14	3.49
Other C&M	3.28	4.56	4.27

Source: Authors' research

4. Weak renewal of capital production assets

The weak renewal of capital production assets leads to their gradual obsolescence.
It is possible to estimate the probability of occurrence by the analysis of the renewal rate of capital production assets in the form of a ratio of the value of the commissioned capital production assets and the cost of the capital production assets at the end of the period.
Negative dynamics in the planned period compared to the baseline indicates a high probability of a risk situation; however, positive dynamics indicates a low probability of a risk situation.
Damage is defined as investment expenses aimed at increasing the renewability of capital production assets associated with the purchase of new equipment (see table 5).

Table 5. Calculating the renewability of capital production assets of Spektr, LLC for 2017-2019

Indicator	2017	2018	2019
Commissioning of capital production assets, thousand rubles	63,587	74,896	82,354
Cost of capital production assets at the end of the period, thousand rubles	1,210,009	1,271,448	1,339,228
Capital production assets renewability ratio	0.05	0.06	0.06
Renewability growth rate, %	-	112.09	104.39

Source: Authors' research

According to the data presented in table 5, we can say that the capital production assets renewability ratio of Spektr, LLC has positive dynamics in general. In the periods defined, the investment activity of the participant of technological integration increased.
This fact is due to the replacement of outdated equipment with an advanced one. In the periods mentioned, the impact of this risky situation on Spektr LLC funds was not revealed.
The following risks can be considered specific in the case of technology and equipment:

1. The risk associated with violation of the operation manuals, obsolescence and wear and tear of the equipment; inadequate reliability of the equipment; violation of the equipment's lifespan.
Concerning the participant of technological integration, the group of these risk situations is connected with the availability of modern capital production assets their optimal use.
These risk situations can be assessed by evaluating the equipment and calculating the following rates of obsolescence and wear and tear of the equipment. With high physical wear and tear, the equipment's profitability decreases due to increased operating costs and reduced productivity.
Obsolescence usually comes before physical wear and tear and can be of two types.
The first type of obsolescence leads to the cheapening of equipment production in new conditions. The second type of obsolescence occurs in the case of the operation of low-performance obsolete equipment, which significantly increases the cost of production.
Thus, when calculating these coefficients in reporting and planning periods, you can determine the likelihood of these risks.
The damage from these risks will include investment costs for buying new equipment.
The wear and tear and obsolescence of Spektr LLC assets can be estimated according to table 6.

Table 6. Calculation of wear and tear of capital assets of Spektr LLC for 2017-2019, %

Indicators	31.12.2017	31.12.2018	31.12.2019
Physical wear and tear of capital assets	57.00	63.19	68.53
Obsolescence of capital assets	24.80	24.44	24.66

Source: Authors' research

The indicator of physical wear shows negative dynamics due to a large number of outdated technological equipment, 31 years old on average. The probability of this risk situation is high for the participant of technological integration.
The indicator of obsolescence for 2017-2019 remained at the level of 24% to 25% due to the gradual obsolescence of the equipment and its replacement with the advanced one.

This risk situation may have an impact on the technological integration participant's activities, but the impact will be minimized if this ratio is maintained at the same level.

Management is mainly associated with the risk of reduced management in the face of rising production.
With production volumes rising, there is a risk of the inefficiency of the organizational management structure. To calculate the probability of a risk situation, it is necessary to calculate the planned integral indicator of the effectiveness of the organizational management structure. The probability in this case is the ratio of an integral indicator based on the planned calculations of coefficients to the normative indicator. It is difficult to determine the damage by this risk because we cannot predict in which part of the organizational structure there will be a decrease in controllability. To determine the damage, it is necessary to examine in detail those indicators that deviate from the normative indicator to a greater extent.
Marketing usually faces the following risk situations:

1. Long production and financial cycle.

In their activities, participants of technological integration are engaged in production and financial cycles when they purchase goods and materials, produce and sell finished products, thus repaying receivables. The reduction of these cycles in dynamics is a positive trend and their increase is considered to be a negative trend.
A long production and financial cycle usually results from a long-term production of finished products, thus it is necessary to maintain a high level of advancing. The probability of this type of scientific and technological risk can be estimated by calculating an average production and financial cycle of the business entity. It includes the production cycle, the cycle of receivables, and the cycle of payables. These coefficients form the production and financial cycle. The high value of this indicator shows us a high probability of this risk event. In the absence of a sufficient level of advancing, it may result in additional costs for the participants of technological integration because they will have to produce goods at the expense of their resources. If a participant of technological integration carries out its current activities using loan assets, the amount of damage from this risk situation will be calculated according to the interest on loans.

2. Supply failures

This risk situation includes the risks of late, incomplete and substandard supply of raw materials, as well as a failure to meet the needs of the participant of technological integration. The logistics department and the equipment department are usually responsible for this group of risks. This risk situation may arise from the conclusion of a supply contract with an unreliable supplier, as well as from the absence of the production capacities of the supplier. The probability of this risk situation can be assessed by analyzing the reserve stock of the participant of technological integration. If the level of reserve stocks is sufficient, the participant of technological integration can produce goods without supplies and has enough time to renew the stocks if necessary. Damage equals the volume of unproduced goods due to supply failures.

3. Insufficient definition of the demand for manufactured goods; unreliable definition of the market share.

Marketing service is vital to quickly adapt a participant of technological integration to consumers' needs, innovations, and market conditions. The marketing service also helps the participant of technological integration understand how to enter new markets and promote goods at existing markets. The absence of this service increases the probability of external risk factors, such as demand and markets. If you have a marketing service, the probability of these risks can be reduced significantly. In the absence of marketing service this probability increases. The damage from this risk situation is difficult to assess, as it relates to external risk factors that have a high degree of uncertainty.
Finance has its specific risk situations:

1. Increase in prime cost.

In an unstable market situation, currency fluctuations lead to an increase in the price of imported equipment and components, which increases the prime cost. The essence of this risk situation is as follows: the prices of goods are subject to an agreement with customers who may not take this increase into account.
Consequently, such orders will remain unprofitable for participants of technological integration. The probability of this situation depends on the probability of a currency appreciation. The amount of loss, in this case, will be the number of profits lost by the participants of technological integration on orders.

2. Falling profitability and, as a result, a decrease in return on the investment.

In most cases, the risk of falling profitability is related to investment activities. The degree of risk increases together with increased uncertainty, as well as due to the rapid volatility of the economic situation in the country in general, and in the investment market in particular. This risk situation is leveled with the right choice of investment projects and their rational initial assessment. In the process of project implementation, it is important to monitor the situation.

3. Risks of delay of contractual payments

This risk situation has a significant impact on associate contractors of the order contracts, as they will receive money for the goods delivered only after the money is received by their head contractor. This necessitates that the participant of technological integration has enough money to carry out the current activities. If there is no money, financing of current activities is possible through loans. This leads to the need to pay interest.

The damage in this risk situation will be the cost of interest payments for the use of loans.
Innovation has its risk situations:

1. Inadequate research and development (R&D) efficiency; a low share of high technology products.

The high risk, in this case, is the risk of underperformance of R&D, which is assessed by the R&D performance indicator. The low share of high technology products is characterized by the R&D intensity coefficient of manufactured goods. This coefficient reflects the outstripping growth of R&D costs in the structure of material production. This risk situation can be detrimental to the participants of technological integration because the funds invested in R&D may not be used in the activities of the participant of technological integration, so the investment will not pay off.

2. Low-level innovation funding.

Innovative projects are highly insecure at all stages of the innovation cycle. Even the most successful projects can fail at any point in their life cycle because a competitor can always produce something more promising or advanced. That is why the participants of technological integration are reluctant when it comes to investing their money in innovation. Any innovative project also has a rather long implementation period.
That is why it is so difficult to consider the time factor when developing the project. This issue may cause an increase in the project implementation cost due to the change of any internal or external conditions. The probability of this risk situation is difficult to determine and the damage will be defined according to an increase in the cost of innovative project implementation due to incorrect planning.

The risk situations associated with existing staff of participants of technological integration can be as follows:

1. Low staff activity in taking management decisions.

This risk situation is considered to be significant in the activities of any participant of technological integration, as many of them still adhere to the traditional management model, where the opinions of ordinary workers are poorly taken into account so that there is a chance to miss the right management decision. In this situation, you need to have tools to improve the interactions of the upper and lower layers in the management hierarchy. It is difficult to assess this risk situation mathematically, so it is necessary to analyze in detail all the tools available to the participants of technological integration and used to improve the interaction of their employees to be able to identify any shortcomings of said interaction.

2. High degree of dependence on highly qualified professionals, as well as the lack of the latter in the process of orders completing.

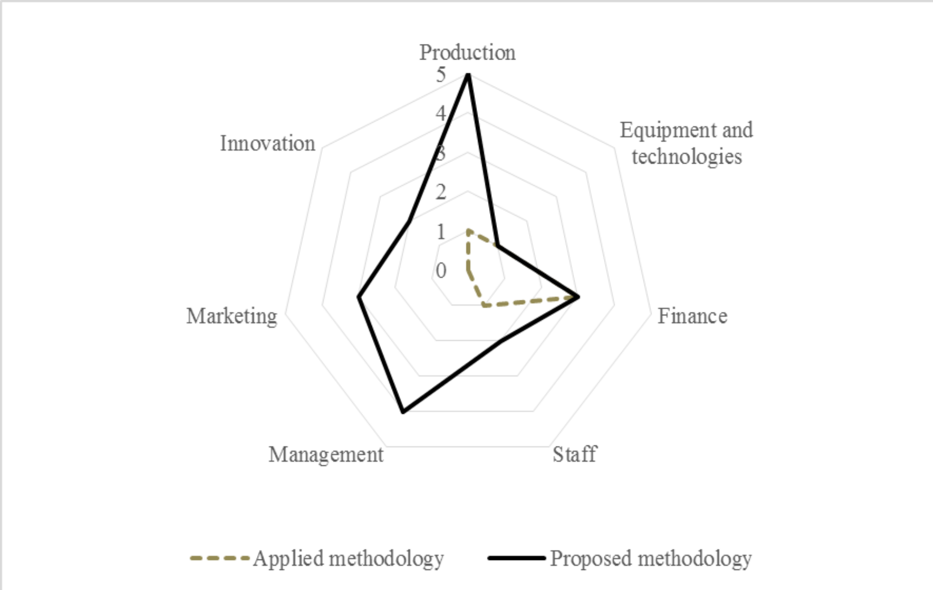
The high proportion of R&D staff in the staff structure is related to the specifics of the goods produced, namely, high technology products and scientific developments.
Since the basis for obtaining a positive result in the course of these activities is a large R&D base, most of the staff of the participants of technological integration in manufacturing industries should consist of the high-skilled workforce.

The probability of this risk is connected to the low ratio of highly qualified professionals.
The benefits of the suggested methodology would be the ability to regulate risk classification based on a standard available to participants of technological integration; and quantification of scientific and technological risks.

The research classifies the scientific and technological risk factors and allows to expand the range of analyzed risks for the participants of technological integration, as well as to apply operational monitoring to identify new risk areas.

The differences in the identified internal factors of scientific and technological risks and risk situations are presented in picture 1:

Picture 1. Comparison of classification of internal risk factors used in the suggested methodology for assessing scientific and technological risks and the existing methodology



Source: Authors' research

This figure shows that the classification of internal factors of scientific and technological risks in the suggested methodology is wider than in the existing methodology. Compared to the existing methodology, the suggested methodology also allows identifying new risks. The number of risk situations in the suggested methodology is also higher. It means that this classification allows conducting a more detailed and in-depth analysis of all risk situations. Thus, the effectiveness of the suggested methodology is justified by the fact that it allows one to anticipate much more risks. In this case, it becomes possible to identify and compensate them at an early stage.

DISCUSSION

The research on instrumental assessment of the scientific and technological risks of technological integration points to the need to identify the key criteria for the methodology of assessing the scientific and technological risks of participants of technological integration. The first criterion is the preference for quantitative methods of assessment to avoid subjectivity. The classification attributes of scientific and technological risks should be consistent with all participants of technological integration. To theoretically justify the development of the methodology for assessing scientific and technological risks, it is necessary to give reasons for a methodical approach to the development of classification attributes. The methodological orientation of the research to the object and the principles of the overall research strategy can prove to be a viable methodical approach.

The methodical approach to developing a methodology for assessing scientific and technological risks contains the following main steps: assessment of the external and internal environment of participants of technological integration; defining classification attributes of factors of scientific and technological risks; identification of the nature of risk situations, as well as the possible consequences of their occurrence; assessment of scientific and technological risks. The management of scientific and technological risk should be based on setting the goal of this management. This can include minimizing scientific and technological risk, optimizing it or eliminating it. The classification of scientific and technological risks is a set of risk situations. Thus the goal of scientific and technological risk management is to optimize risk situations.

Assessment of the internal and external environment of participants of technological integration forms risk areas. They are used as the basis for the classification of factors of scientific and technological risks, which in its turn becomes the basis for risk situations occurring in any risk area. For example, an analysis of the internal and external environment has shown that manufacturing activity is the main risk area. In this risk area, we can define a large number of factors of scientific and technological risks, including the risks of production. Risk situations may include such factors as incomplete production capacity, limited production capacity, and poor renewability of capital production assets. Thus, risk situations serve as the smallest component of the classification of scientific and technological risks. The difference between these concepts is as follows: a risk area is the area of activity of participants of technological integration where positive or negative consequences of scientific and technological risks will manifest themselves. The factor of scientific and technological risks is a risk category included in the risk area as the source of risk situations. A risk situation is a minimum structural risk unit that has positive or negative effects. At the same time, we should take into account certain conditions that may provoke a risk situation: the presence of a real source of scientific and technological risk and participants of technological integration being in the area of this source without the necessary protection means. Therefore, if none of these conditions is met, there is a high probability the risk situation will not happen.

To assess the environment, we can research changes affecting scientific and technological risks, as well as and risk situations. This assessment should start with an external environment of a direct impact, namely consumers, competitors, suppliers, etc. The external environment of an indirect impact defines the conditions of the activities of each technological integration participant; its analysis helps to define their development tendency. Assessment of the internal environment allows classifying internal factors that influence scientific and technological risks; assessment of the external environment allows classifying external factors.

Assessment of the internal and external environment allows identifying risk areas and shows that participants of the technological integration in manufacturing industries have a substantial technological and production capacity, as well as wide opportunities. At the same time, considering the current economic conditions there are some shortcomings related to the existing obsolete equipment, the need for highly qualified personnel and other inherent participants of the technological integration in manufacturing industries. Physical (actual) wear and tear of the equipment is 80% and the average age of technological equipment is 31 years. Emerging risk areas reveal the possible factors of scientific and technological risks. The same types of scientific and technological risks may be included in several risk areas. At the same time, the weaknesses of the participants of the technological integration in manufacturing industries allow us to formulate the main internal factors of scientific and technological risks.

The high degree of equipment wear and tear poses a risk of non-performance due to the unreliability of obsolete equipment. Therefore we can formulate such factors of scientific and technological risks as production, equipment, and technology. The high dependence on suppliers of the components also creates a risk of non-compliance with the planned production volume in case of disruption of delivery times. In this case, the production also becomes a risk factor. The demand for highly skilled staff roots in the fact that the majority of participants of technological integration needs to maintain a certain number of R&D specialists and key production workers. The lack of highly qualified personnel entails a great risk of failure to implement R&D results. In this case, personnel become a factor of scientific and technological risk. The lack of a strong marketing service and the absence of a marketing strategy lead to a whole range of risks associated with insufficient product demand research and poor promotion of goods to new markets. Lack of well-planned logistics leads to interruptions in the supply of raw materials and components, which, in its turn, leads to the delayed launch of products into production.

Constant factors of scientific and technological risks also influence the activities of participants of technological integration. These risk factors include management, finance and innovation. These are the factors that have a significant impact on the activities of participants of technological integration. They can be manifested when production volumes increase or processes are optimized.

The list of threats makes it possible to identify external factors of scientific and technological risks. Uncertainty in contractual policy and export uncertainty are linked to the high dependence of technology integration participants on their domestic and foreign policies. All of this creates the economic factors of scientific and technological risks associated with instability of both domestic and international markets. This threat also involves risk factors such as demand, sales, and supply of products. The instability of the market situation is an economic risk factor that has a significant impact on the activities of participants of technological integration. The participants of technological integration may have competitors in the domestic and foreign market. This issue can be further complicated by high entry barriers, but since the damage from this risk is quite high, it cannot be ignored, as it actualizes such a factor of scientific and technological risk as competition.

CONCLUSION

Thus, the quantitative method used to assess the scientific and technological risks of technological integration makes it possible to conduct rapid monitoring of risk factors and minimize the number of errors in the final assessment of the possible extent of damage from the occurrence of risk situations and the probability of their occurrence.

The methodology of assessing the scientific and technological risks of technological integration can be used at enterprises from any industrial field. It allows assessing the vector orientation of the main feasibility indicators objectively, to assess the dynamics of their changes, both in the short and the long term. The undeniable advantage of the development of the assessment tool associated with the scientific and technological risks of technological integration is that it allows changing the approaches to forecasting and planning of the production activities of participants of technological integration. The development of technological integration stimulates the search for new integrated ways of assessing the performance of production activities, taking into account possible risk factors at the proper time.

We therefore may conclude that the development of a quantitative method of assessing the scientific and technological risks of technological integration will not be linear. The vector orientation of the quantitative method of assessing the scientific and technological risks of technological integration can change under the influence of technical, technological, and organizational changes in production activities, environmental factors, and targeted administrative influences. Time-efficient monitoring of the vector orientation of the development of the quantitative method of assessing scientific and technological risks allows us to make regular adjustments to the key parameters of manufacturing activities of manufacturing industries.

REFERENCES

[1] Chung, Ch. Yo., Kim, D., Lee, Ju. (2020) *Do Institutional Investors Improve Corporate Governance Quality? Evidence From the Blockholdings of the Korean National Pension Service*. Global Economic Review. Vol. 49 (4). 422–437. DOI: 10.1080/1226508X.2020.1798268.

[2] Gong, R. (2020) *Short selling threat and corporate financing decisions*. Journal of Banking & Finance. Vol. 118. 105853. DOI: 10.1016/j.jbankfin.2020.105853.

[3] Keynes, J. M. (2012) *The General Theory of Employment, Interest and Money*. The Collected Writings of John Maynard Keynes. Cambridge University Press. 2012. Vol.VII.

[4] Knight, F. H. (1965) *Risk, Uncertainty and Profit*. New York

[5] Markowitz H. M. (1990) *Mean Variance Analysis in Portfolio Choice and Capital Markets*. Basil. Blackwell.

[6] Marshall, A. (1993) *Principles of economics*. The Macmillan Press Ltd

[7] Hao, XC., Sun, QR., Xie, F. (2020) *Does foreign exchange derivatives market promote R&D?* International industry-level evidence. Economic Modelling. Vol. 91. 33–42. DOI: 10.1016 / j.econmod.2020.05.019.

[8] Neumann, J., Morgenstern, O. (1953) *Theory of games and economic behavior*. Princeton university press.

[9] Hsu, S., Li, JJ., Bao, H. (2020) *P2P lending in China: Role and prospects for the future*. Manchester School. Jun 2020. DOI: 10.1111/manc.12332.

[10] Susie, M. C., Noja, G. G., Cristea, M. (2020) *Diversity, social Inclusion and Human Capital Development as Fundamentals of Financial Performance and Risk Mitigation*. Amfiteatru Economic. Vol. 22 (55). 742–757. – DOI: 10.24818/EA/2020/55/742.

[11] Tohanean, D., Buzatu, A. I., Baba, C. A., Georgescu, B. (2020) Business Model Innovation Through the Use of Digital Technologies: Managing Risks and Creating Sustainability. Amfiteatru Economic. Vol. 22 (55). 758–774. – DOI: 10.24818/EA/2020/55/758.

[12] Yang, W. Yo., Han, B. S. (2020) *The Effects of Compliance Timing on Multinational Enterprises' Corporate Performance in China: An Application of Institutional Perspectives.* Journal of Korea Trade. Vol. 24 (4). 71–94. DOI: 10.35611/jkt.2020.24.4.71.

[13] Zhao, K., Huang, H. H., Wu, W. S. (2020) *Shareholding structure, private benefit of control and incentive intensity: from the perspective of enterprise strategic behavior*. Economic Research-Ekonomska Istrazivanja. AUG 2020. DOI: 10.1080/1331677X.2020.1805345.

ACKNOWLEDGMENTS

The reported study was funded by RFBR according to the research project № 19-010-00081.

SUMMARY

The expected results are in line with the current global economic trends and the global priorities of a technological shift in the production and economic activities of industry entities. These results are expressed in the methodology of assessment of scientific and technological risks of participants of technological integration developed within the research. The methodology

complements the neoclassical theory of risk, thereby contributing to the justification of the modern scientific base of global economic research, as well as to the theoretical justification of the content and development of the implementation of the organizational and economic model of technological integration in the manufacturing industry under the sanctions. It forms a list of fundamentally new areas of the research on the process of technological integration, both in manufacturing industries and in enterprises of various industries.

The article emphasizes the need to develop a new scientific methodology used to assess the scientific and technological risks of participants of technological integration in manufacturing industries. It is aimed at revealing the versatility of content and expands the range of implementation of the features of technology integration in the manufacturing industry within the priorities of the development of the Russian scientific and technical complex. The suggested methodology for assessing the scientific and technological risks of technological integration in manufacturing industries reveals the goals and objectives of technological integration, the organizational and management procedure for identifying risk situations, the methodological basis for the formation of risk areas in manufacturing industries in a dynamic external environment. The suggested methodology is different from the conventional one in the following ways: it provides a systematization of classification factors of scientific and technological risks and ensures that risk situations can be classified according to a definite risk factor. The suggested conceptual idea develops the basic elements of neoclassical risk theory, allowing us to consider a significant portion of risk situations both as sources of the existence of other risks and as risk situations' consequences. The methodology will be based on an instrumental approach to the formation of modern processes of technological integration, quantification and parametric methods, which are the basis of the evaluation toolkit that forms the technology of assessing scientific and technological risks.

As part of the practical implementation of the methodology for assessing scientific and technological risks, we justify the transformation of risk areas, allowing minimizing possible losses. This necessitates the development of a methodical approach that needs to be based on quantitative assessment methods. The advantage of the quantitative assessment method is the ability to formalize the results of the assessment. It becomes possible due to a wide toolkit of mathematical statistics.

Risk situations are the most specific and the damage from their onset is easily measurable. That is why they need to be quantified. In the course of quantification of scientific and technological risks, it is possible to use two types of indicators: objective and subjective. Objective indicators are characterized by independence from the participants of technological integration; they can be attributed to inflation, market competition, environmental issues, etc. Subjective indicators include those that characterize the condition of participants of technological integration, such as production and innovation potential, the technical level of production, reliability of their counterparties. The benefits of quantifying a risk situation are: 1) the ability to quantify the amount of loss or profit from a risk situation, which may be the subject of a risk management procedure; 2) a high probability of identifying factors of scientific and technological risks requiring rapid response; 3) the high degree of influence of various factors of scientific and technological risks; 4) the ability to prepare a framework for developing rational options for the behavior of the participants of technological integration in a risk situation; 5) the availability of quantitative information regarding the assessed risks. The suggested methodology of quantifying scientific and technological risks can achieve this goal and influence the development of technological integration of manufacturing industries.