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Optimization of labor processes in innovation enterprises of Russia

Оптимизация трудовых процессов на инновационных предприятиях России

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Abstract

The article shows the need to optimize management decisions to improve the efficiency of labor organization in innovative enterprises. The main tasks of the scientific organization of labor (SOL) for existing and innovative processes are presented. The use of methods of research operations and modeling to optimize labor processes is considered.

Keywords: engineering, high-tech production, mathematical methods of operations research, modeling, optimization, scientific organization of labor.

Аннотация

В статье показана необходимость оптимизации управленческих решений для повышения эффективности организации труда на инновационных предприятиях. Представлены основные задачи научной организации труда как для существующих, так и для инновационных процессов. Рассмотрено использование методов исследования операций и моделирования для оптимизации трудовых процессов.

Ключевые слова: высокотехнологичное производство, математические методы исследования операций, моделирование, оптимизация, машиностроение, научная организация труда.

Introduction

The aviation industry is one of the high-tech sectors of the country's economy, ensuring the development and production of military and civil products, the level of which largely determines Russia's economic, technological, information security and defense

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capability. A lot of industries, for example, electronic and radio industries act as suppliers to ensure the smooth operation of the aviation industry. Aviation technologies are the catalyst and the engine of the country's scientific and technological progress and the basis for the sustainable development of other industries. The aviation industry market is one of the most capacious and fast-growing, and has a great potential for further development.

The aviation industry of Russia is characterized by the need to introduce external regulation. This regulation should be focused on reducing adverse factors and enhancing the beneficial effects of aeronautical engineering on the development of the country, which is very significant. One of the important tools for managing an aircraft manufacturing enterprise is the planning apparatus for the effective development of enterprises and increasing the productivity of workers (Kanashchenkov, Matveev, Minaev & Novikov, 2017).

The results of investigations of the Russian Academy of Sciences on the study of the behavior of Russian enterprises show that low labor productivity in high-tech aviation enterprises is connected with management inefficiency. Reducing the possibility of obtaining income by the enterprise did not lead to the strengthening of internal control systems, did not take into account the factors of productivity, competitiveness, resource saving, improved planning, effective organization and optimization of production processes (Pinkovetskaya, 2015; Novikov, 2018).

Methodology and labor organization solutions

During the research conducted by Professor Rodionova N.V. it was found that “Russian enterprises have shown poor quality management. Thus, according to economists, in the domestic economy, no more than 25% of all disposable resources are actually mastered, including: human — 15%, financial — 10, intellectual — 3.3. With the same material reserves possessed by Russia, other countries receive 2—3 times higher volumes of GDP, 3—4 times foreign currency earnings and 4—5 times tax revenues. Russia produces 0.63 units of GDP per unit of total energy costs, while the United States produces 2.9 units, which is 4.6 times more”. Labor productivity in Russia is 3—4 times lower than in developed countries. For aviation enterprises, this discrepancy is even more significant, as according to the data in 2017, the output per employee of the aircraft industry was an order of magnitude lower than in the major world aviation centers. According to the state program for the development of the aviation industry for 2013–2025 (Mitrofanova, Demjanchenko, Novikov, Rudakova & Shmanev, 2017), it is planned to increase the productivity of industrial aircraft building organizations to 19,184 thousand rubles per person per year by 2025, that is, more than 10 times. According to the adopted program, by 2025, reducing the cost of the supplied aircraft based on increasing labor productivity will amount to 3.2 and 10.9 percent of the global market share in terms of money in civil and military aircraft manufacturing, respectively.

Increasing labor productivity growth rates, in the context of the introduction of new high-performance equipment and advanced high-tech at enterprises, is unthinkable without continuous improvement and optimization of work organization solutions. The main task of the organization of labor is to minimize the labor process in time and space while obtaining high production results, quality and competitiveness of finished products and preserving the working capacity of workers. Achieving this goal is only possible on a scientific basis. SOL implies the systematic introduction of scientific research and

advanced experience into high-tech aviation production (Novikov, 2018). SOL allows the best way to combine technology and people in a single production process, ensures efficient use of material and labor resources, continuous increase in labor productivity contributes to the preservation of human health. All this concerns both existing and innovative processes, which, as a rule, initiate changes in the content of labor, improvement of its organization forms, which are predetermined by the nature of technological processes used at aviation enterprises (Mindlin, Novikov, Kireev, Adamenk & Belitskaya, 2016; Novikov, 2018).

Without compliance with the level of work organization and the development of technology and production technology, the most advanced innovative solutions will not give the desired result. Otherwise, there are disparities in the level and quality of organizational decisions, which leads to a significant reduction in productivity growth.

In the conditions of increasing the technical equipment of labor, automated production, human functions in high-tech production change: from executive to regulatory duties. The functions of controlling the progress of the productive process, setting up and caring for the equipment, selecting and programming the optimal mode of its operation become predominant. In this case, the introduction of such forms of work organization, which allow the most efficient use of equipment, materials and achieve high productivity of labor with the least expenditure of nervous and muscular energy is of particular importance. To achieve an economical effect, it is necessary to fully take into account the peculiarities of aviation production, which is characterized by the use of advanced technologies and the realization of the full potential of domestic producers of high-tech goods (Novosadov, Burtseva, Repetskaia & Novikov, 2017; Kraev, Tikhonov & Novikov, 2018).

The solution of tasks in the field of labor organization depends on the equipment and technology used, the nature of the product, the type of production. At the enterprises of the aviation industry, for example, the continuity of technological processes, large dimensions and power of the operated units determine the use of collective forms of work organization. The main products are manufactured at the technological equipment with numerical program control and flexible automated production facilities. Volumes of production of high-tech aircraft engineering products are in a wide range — from single samples to mass production (Novikov & Dmitriev, 2018).

To ensure the continuity of technological processes, it is necessary to coordinate carefully in space and time, not only the work of the production team, but also the labor functions of workers employed in servicing, transport shops and other services of pre-production and production logistics. With an uneven production process, when the need for maintenance arises at random moments, and machine downtime is inevitable while waiting for service or workers waiting for service requirements, the task of organizing service for a high-tech aircraft manufacturing process is quite complex. Proper scheduling of work methods, service route minimizes equipment downtime and efficiently uses work time (Pinkovetskaia, Lyubovtseva, Arbeláez-Campillo & Rojas-Bahamón, 2020).

In engineering, the specifics of organizing the production of high-tech products are determined by the variety of equipment used and technological processes, the type of production, the nomenclature, and the complexity of the product. Produced products include a wide range of different complexity of machines and parts. At machine-building

enterprises with a high level of automation, a wide distribution of multi-station service and the combination of professions of a production and conveyor line have become widespread (Pinkovetskaia, ArbeláezCampillo, Rojas-Bahamón, Gromova, & Nikitina, 2019).

A very complex system of services for the main production is characteristic of the organization of labor at a high-tech enterprise (Nedelkin, Novikov, Titov, Mikhailova & Popova, 2017).

Large reserves of accelerating the growth of labor productivity lie in improving the use of equipment, production space, eliminating the loss of working time, which is largely determined by the level of optimization of organizational decisions on labor.

Ensuring coordinated work and effective interaction of people and technology in modern conditions requires new methods based on careful quantitative and qualitative expert analysis of labor and business processes.

Designing the optimal organization of labor should be based on the qualitative and quantitative assessment of its various options, and boil down to choosing the optimal one, which cannot be done without building a mathematical model of the labor process and using the methods of applied mathematics. Areas of application of expert methods in making organizational decisions are used for the analysis and subsequent adoption of management decisions in the following cases: if objects either completely or partially are not amenable to subject description; in the absence of sufficiently reliable statistics on the characteristics of the object; in conditions of high uncertainty of the environment of the object; in case of lack of time and funds to collect information and making decisions in extreme situations. In case of the application of expert methods, it is possible to bring the qualitative assessment of experts to a quantitative form. Thus, for most organizational decisions, we can recommend quantitative analysis and the use of mathematical modeling.

Modern high-tech industrial enterprises are complex systems whose functioning depends on the high-quality organizational management of them. Choosing this or that organizational decision, it is necessary to take into account various contradictory factors and disturbing influences acting on the enterprise (Fedotova, Tikhonov & Novikov, 2018).

In solving a wide range of problems of optimal control, scientific methods of organizational management are used — operations research, i.e. the choice of optimal (according to a particular criterion) options for organizing and managing targeted processes (operations) based on the construction for its analysis of the mathematical apparatus.

Solving specific tasks of production organization, the use of methods of operations research suggests:

- building economic and mathematical models that are adequate to the object under study for the tasks of making organizational decisions in difficult situations or in conditions of uncertainty;

- study of interrelations that determine the consequences of making decisions, and the establishment of performance criteria, allowing to evaluate the advantage of a variant of action.

The mathematical model of the labor process stands for a system of its characteristics, their interrelations, limitations in mathematical expressions.

Solution to the problem, which provides the optimal, i.e. the maximum (or minimum depending on the content of the task) value of the efficiency criterion and compliance with the limitation is called optimal, it shows which set of organizational measures must be implemented in practice so that the work process becomes the most effective (in terms of the chosen criterion).

The model may also additionally take into account qualitative factors. A comprehensive qualitative and quantitative analysis of an organizational task that precedes the construction of a mathematical model is an integral part of the methodology of operations research. This analysis is carried out in accordance with the principles of the systems approach and involves the identification of all significant relationships between the influencing factors of the subsystems.

The main difference between the organization of labor using mathematical methods from designing the organization of labor in the traditional way is that a model of the labor process is developed, which allows quantitative substantiation of various options for organizing labor and choosing the best one by experimenting abstractly without conducting experiments on high—tech production.

Models of work processes can be very complex mathematical expressions. However, they are based on a relatively simple design. All of them have the form of an equation in which the performance criterion (Z) is a function f of the set of variates (x_i) determining the content of the labor process.

$$Z=f(x_1, x_2, x_3, \dots, x_i, \dots, x_n)$$

The equation is called performance function or objective function. It expresses the dependence of the efficiency criterion on the essential variates describing the real labor process.

Prospects for the implementation of the model add to the performance function a number of expressions, equations and inequalities representing the constraints that are imposed on the possible values of the variables, determined by the production capabilities and the resources used.

A specific set of variable values that satisfies these additional conditions is called the solution to the problem. Different sets of variables form a set of solutions. Each of the solutions corresponds to a set of organizational measures, the content of which depends on the nature of the variables being changed.

Working at a mathematical model, attention is focused on formal relations, but this formalism makes it possible to display the content of the real labor process, transferred to the formal scheme of the model. The visibility and adequacy of the model to the process

being studied, the ability to focus on the formally presented properties of the labor process allows clarifying the identified structure of the process and determining the direction of research to further refine the model in order to take into account the essential relationships that exist in reality more completely. This shows the active role of mathematical models: with their help, you can once again check that everything important is taken into account and discard irrelevant details.

Evaluation of the relevance of preserving and prospective development of high-tech aviation enterprises, as well as researching the experience of making managerial organizational decisions on labor showed that the cause of the constant internal reorganization of the object and subject of management is the inefficient use of resources of the knowledge-intensive organization (Sozinova, Novikov, Kosnikov, Nemchenko & Alenina, 2016). The organization systems of production applied at Russian enterprises turned out to be insufficient in the conditions of a rapid technological change.

Existing management decision-making systems most often inadequately reacted to events that are partly predictable, but are developing rapidly in relation to high-tech markets (Novikov & Veas Iniesta, 2018).

High-tech, knowledge-intensive industrial aviation enterprises often find themselves unprepared for this situation both from the point of view of resources and from the point of view of the lag of time to make the necessary decisions. It is required to improve the existing management systems by identifying, planning and optimizing the adoption of organizational decisions on labor.

Conclusion

Thus, in this paper, the following statements and results are new:

- necessity of a significant increase in growth rates of labor productivity for a high-tech aircraft engineering enterprise is shown;
- it is revealed that the increase in labor productivity growth rates, in the context of the introduction of new high-performance equipment and advanced high-tech at enterprises, is unthinkable without continuous improvement and optimization of labor organization solutions;
- It is shown that in solving a wide range of problems of optimal control, scientific methods of organizational management — investigation of operations, i.e. the choice of optimal (according to a particular criterion) options for organizing and managing targeted processes (operations) based on the construction for its analysis of the mathematical apparatus.

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Application of the cumulative theory of prospectuses to identify the degree of risk solutions in the implementation of high-tech innovation projects

Применение кумулятивной теории проспектов для идентификации степени рисковых решений при реализации проектов в сфере высокотехнологичных инноваций

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Abstract

This article is devoted to the peculiarities of the application of cumulative theory of prospectuses to identify the degree of risk decisions in the implementation of projects in the field of high-tech innovations. In the theoretical part of the article, the authors note that obtaining an assessment of the degree of efficiency of investments in various large innovative projects is a rather laborious and complex process, in which a special place should be given to the analysis of the risk of the investments themselves. As an effective way to assess the level of risk present in the implementation of innovative projects, the authors of the article study the cumulative theory of the prospectuses, based on the theories of utility and management decision making, created by Daniel Kaneman and Amos Tversky. Furthermore, the authors underline that if the administrative decision is accepted in the conditions of uncertainty, it should necessarily consider various psychological factors in comparison with classical models of decision-makin, which are constructed on conditions of the maximum availability of the information. In the research part of article, the authors consider a way of an estimation of integral risks of innovative projects. In the final part of article, the authors come to the conclusions that the algorithm of an estimation of risks of innovative projects should obligatory include, not only an expert estimation at an initial stage, but also the subsequent adjustment of the values received after the decision taken regarding the optimization problems.

Keywords: application of cumulative prospectus theory, innovative high-tech projects, Kaneman-Tverski function, optimization methods, risk level analysis.

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Аннотация

Статья посвящена особенностям применениям кумулятивной теории проспектов для идентификации степени рисковых решений при реализации проектов в сфере высокотехнологичных инноваций. В теоретической части статьи авторы отмечают, что получение оценки степени эффективности инвестиций в различные крупные инновационные проекты является довольно трудоемким и сложным процессом, в котором особое место необходимо отвести анализу степени риска самих инвестиций. В качестве эффективного способа оценки уровня риска присутствующего при реализации инновационных проектов, авторы статьи рассматривают кумулятивную теорию проспектов, в основе которой лежат теории полезности и принятия управленческих решений, созданные Даниэлем Канеманом и Амосом Тверски. Авторы статьи подчеркивают, что если управленческое решение принимается в условиях неопределенности, то оно должно в обязательном порядке учитывать различные психологические факторы, в сравнении с классическими моделями принятия решений, которые построены на условиях максимальной доступности информации. В исследовательской части статьи авторы рассматривают способ оценки интегральных рисков инновационных проектов. В заключение статьи авторы приходят к выводам, что алгоритм оценки рисков инновационных проектов должен в обязательном порядке включать в себя, не только проведение экспертной оценки на начальном этапе, но и учитывать последующую корректировку значений, получаемых после решения оптимизационных задач.

Ключевые слова: анализ уровня риска, инновационные высокотехнологичные проекты, оптимизационные методы, применение кумулятивной теории проспектов, функция Канемана-Тверски.

Introduction

Conducting a procedure to assess the efficiency of various types of investments in modern innovation projects is usually a rather complex task, which in the current economic realities can be successfully solved if it takes into account the direct investment risks. Innovation projects are highly exposed to risks that have a direct impact on investment performance throughout the innovation process, which is presented as a cycle. In the case of risk factors, there are significant losses in innovation efficiency: for example, the result of a group of risk factors in innovation, which may lead to the need for early termination of the project, even though the funds invested in its development are significant. Such factors could also include (Drogobytsky, 2018):

- the possibility of obtaining a number of negative results related to the product testing processes of an innovative nature;
- the impossibility to develop a set of project documentation within the established deadlines;
- the possibility of the appearance of hi-tech companies with more competitive products/services in the market.

If an innovation project is terminated prematurely, the enterprise can expect to receive only an insignificant amount of the value stipulated in the liquidation fund. Therefore, it may lead to a decrease in the capitalization indicators of the firm and significantly

increase the probability of default. Therefore, the high-tech enterprise necessarily needs qualitative tools for quantitative assessment of risk of the possibility of termination of the activity of the innovative project. By using those tools, experts of the enterprise can make qualitative and effective decisions in the sphere of the organization and management of hi-tech projects in the sphere of innovations, taking into account possible risk factors. Conducting procedures for assessing the probability of occurrence of scenarios that are pessimistic in view of the high degree of novelty of projects in the field of innovation involve, on the one hand, the almost complete absence of any statistical data and, on the other hand, a very difficult task for specialists and managers of the enterprise (Rukinov, 2020).

Literature Review

Modern economic systems have a largely defined measure of sustainability. The concept of sustainability in relation to economic systems means that the latter have a certain ability that allows them not only to achieve certain results (which have a low degree of possible deviations), but also to use unique recovery mechanisms if the system is affected by negative factors. In complex political, social and economic conditions, the sustainability of economic systems directly depends on the extent to which their internal resources are used, as well as their ability to adapt to the constant changes taking place in the external environment (Sazonov, Mikhailova & Kolosova, 2017; Abdikeev, Bogachev & Bekulova, 2019). Consequently, any modern economic system has to be adaptive in nature, which will enable it to significantly reduce the current level of uncertainty inherent in the system itself, as well as making it sufficiently flexible to be able to respond quickly in the event of deviations from previously planned indicators. The simplest option for stability of almost any economic system is, of course, a state of equilibrium in which it can remain, for a sufficiently long period of time, provided that it is not affected in any way by any hard impact (Kiseleva & Begashev, 2014; Dmitriev & Novikov, 2019).

To date, several approaches have been identified to address the problems associated with determining the degree of risk present in the implementation of innovative projects, which in turn constitute the following groups (Kuntsman, 2018; Babkin, 2018):

- approaches aimed at establishing and then assessing the various objective probabilities of a possible termination of an innovation project;
- approaches needed to analyse and assess the various subjective probabilities of a possible termination of an innovation project.

When considering the approaches included in the structural composition of the first group, we can distinguish a category of approaches based on the bottom-up principle. In this case, we are talking about a procedure for assessing the probability of the implementation of certain risk factors, followed by a logical summation of individual probability values. It is also necessary to remember the use of the risk absorption rule, which is used to find an integral estimate of the probability of an unplanned termination of an innovation project (Dmitriev & Novikov, 2019; Isaychenkova, 2019). The approaches of the first group make it possible to create a detailed assessment of the level of risk, and analyze each individual factor, which in the end will allow the formation of an integrated risk assessment. It should be noted that when using the bottom-up approach, the probability that risk factors will not be fully considered is significantly increased. In turn, this can lead to an increase in the likelihood of underestimating the risk of a possible

termination of an innovation project (Ananyin, Zimin, Lugachev, Gimranov & Skriprin, 2018; Novikov & Veas Iniesta, 2019). The other group is based on approaches to assessing risk-neutral probabilities of termination of innovative projects caused by the default of the project enterprise itself. At present, the following groups of methods are included in the structure of the main methods for assessing risk-neutral probabilities:

- valuation method based on analysis of market prices for bonds (state and corporate type);
- valuation method based on the analysis of changes in market prices for shares (ordinary, preferred and "golden" type).

The following assumptions are structurally based on risk-neutral approaches (Rakhimova, Kunanbaeva & Goncharenko, 2019):

- investors almost always take a neutral position on risk, i.e. we can say that investors are indifferent to the process of investing in various risk-free assets or in assets with a high probability of risk, with the same predicted return;
- as a rule, financial markets are highly effective instruments, that is, they almost instantly respond to various changes in information and immediately reflect this in the adjustment of prices for various types of financial assets, and it should also be noted that financial market participants are highly qualified and have the professional knowledge necessary for quick and high-quality processing of all incoming information;
- shares/bonds of the project company must have a high degree of liquidity, therefore, various types of trading operations must be performed on the stock market on a regular basis;
- changes in prices for various financial assets present on the market must necessarily be probabilistic in nature, and in no case depend on the behavior of each individual participant working in the market.

The assumptions discussed above indicate a significant limitation, and in the vast majority of cases, the inadmissibility of using risk-neutral approaches for assessing the likelihood of termination of an innovation project in an imperfect Russian market. The decision to implement an innovative project should be made considering many characteristics. Some of them are focused on the economic, environmental and social consequences of the project. The other part takes into account the various risks and uncertainties associated with the implementation of the project. The selection criteria for an innovative project are conditionally divided into the following groups (Romanova, Akberdina & Bukhvalov, 2016):

- target criteria;
- external and environmental criteria;
- criteria of the subject implementing the innovation project;
- criteria for a scientific and technical perspective;
- commercial criteria;
- production criteria;
- criteria for regional features of the project.

The criteria of each group are divided into mandatory and evaluative. Failure to meet the required criteria entails refusal to participate in the project. A group of approaches

based on estimates obtained from the analysis of subjective probabilities of termination of innovative projects involves the active use of expert methods, as well as the application of the model of prospectus theory. Of course, the determination of the subjective probabilities of termination of projects based on the use of expert methods has rather significant drawbacks: for example, the results that were obtained during the examination of the assessment can have a very high level of dependence on the professional skills and knowledge of the expert himself. In the course of many years of work, Daniel Kahneman and Amos Tversky found that investors who are not risk averse, in the vast majority of cases, quite exaggerate the values of small probabilities (less than 0.2) and underestimate the average and values of large values ones. Therefore, this leads to the fact that in many cases, after the procedure of expert evaluations, the result was significantly distorted, which in turn gives one more reason for various manipulations and adjustments, under the result necessary for the enterprise management. As a result, innovative projects with a high degree of risk can easily go into the category of projects with a level that is quite acceptable for potential investors. The opposite situation is also possible, when innovative projects with rather low risk indicators and potentially high efficiency can be almost immediately rejected by the enterprise management, due to the fact that expert evaluations were overrated (Pinkovetskaia, Balynin & Berezina, 2019).

According to Amos Tversky, ideal optimization serves as a benchmark for orthodox proponents of rational choice. Despite this, they do not assume that decision makers do not always choose the option in an ideally optimal way. Decisions in life cannot be made without a factor of fallibility, but proponents of rational choice believe that it is difficult to predict these errors, or, according to a more conservative concept of rationality, it is generally impossible. Amos Tversky's work rejects such vision. He and his colleagues have shown that economic rationality is systematically violated, while decision-making errors are not only widespread, but also predictable (Skripkin, 2017).

Methodology

The theory of prospectuses created by Daniel Kahneman and Amos Tversky is based on the theory of utility and the theory of managerial decision-making. The prospectus theory makes it possible to efficiently solve the problem of analyzing and evaluating the selection process carried out by investors when choosing a potential investment object. The prospectus is an alternative to the selection process in which cash flows are uncertain. The prospectus also considers random losses and acquisitions received by the investor, and can also help establish some starting point from which possible losses and acquisitions can be calculated based on specially encoded information. The weighting model of the prospectus theory is calculated using the following formula (Kovalev & Konoreva, 2015):

$$V(f) = \sum_{-m}^{0} u(x_i) \times \pi_i^- + \sum_{0}^{n} u(x_i) \times \pi_i^+ \quad (1)$$

where u(x) is the function to indicate the utility of money from a possible outcome x. Possible outcomes in this case may be the value of the cash flow currently expected under some scenario k of a possible project development in the field of innovation, which can be calculated based on the following formula (1);

$x_{-m}, x_{-(m-1)}, \dots, x_{-1}$: outcomes that are negative, i.e. possible losses depending on probabilities $p_{-m}, p_{-(m-1)}, \dots, P_{-1}$;

$x_0, x_1, \dots, x_n$: positive outcomes, i.e. possible acquisitions based on probabilities $p_0, p_1, \dots, p_n$;

m, n are the natural numbers, required to determine the number of the maximum negative and positive outcomes;

π_i^-, π_i^+ are the "psychological" weights used in the weighting model, the main purpose of which is to take into account various distortions allowed by investors when assessing positive and negative outcomes.

In the course of experiments, Daniel Kaneman and Amos Tversky determined the following practical properties inherent to the weighing model (Figure 1):

- as a rule, the highest weight for investors with equal conditions is given to extremes, i.e. the best or the worst outcomes;
- the weight of a possible outcome is significantly affected by its position (rank), among other possible outcomes;
- investors quite strongly overestimate small outcomes (less than 0.2) and underestimate average and high probabilities (0.5).

The above-mentioned practical properties of weight relate to a large extent to average investors who are not experts in the field of risk analysis and assessment. Daniel Kahneman and Amos Tversky determined the weights as follows (Kolosova, Sazonov & Vnuchkov, 2018):

$$\begin{cases} \pi_i^+ = w^+(p_i + \dots + p_n) - w^+(p_{i+1} + \dots + p_n) \\ \pi_i^- = w^-(p_{-m} + \dots + p_i) - w^-(p_{-m} + \dots + p_{i-1}) \\ w^{+-}(p) = \frac{p^\gamma}{(p^\gamma + (1-p^\gamma)^{1/\gamma}} \end{cases} \quad (2)$$

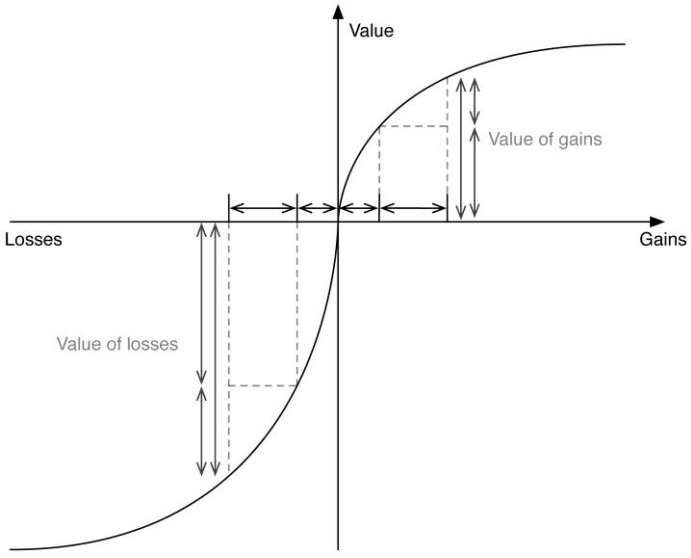

Figure 1. Graphic interpretation of Kaneman-Tversky function application.

The exponent w(p) is called the weight function. The parameter γ of the weight function has various values depending on the acquisition or loss. It must be remembered that the values of the parameter γ in the process of evaluating acquisitions are slightly lower than in assessing losses. Recommended values of the parameter γ are 0,6-0,7. Therefore, it is necessary to take into account the dependence of the sign in the upper index of the estimated area in the formula (2). The «+» sign is considered as an acquisition, and the «–» sign, respectively, as a loss of weight function. As a result, for outcomes characterized by minimum and maximum indicators, we have:

$$\pi_{-m}^{-} = w^{-}(p_{-m}), \pi_{+n}^{+} = w^{-}(p_{+n}) \qquad (3)$$

Method for assessing the integral risks of innovative projects

Let us consider the question of determining the value of the risk indicator using the apparatus of fuzzy sets. A fuzzy set A in U is a collection of pairs of the form$[\mathrm{u}, \mu\mathrm{A}\ (\mathrm{u})]$ where $\mathrm{u} \in \mathrm{U}, \mathrm{a}\mu_{\mathrm{A}}(\mathrm{u})$ is the membership function of the elements of the fuzzy set A: $A\mu_A: U \to [0,1]$. Here U is is a universal set, a collection of elements of some kind. For each element $\mathrm{u} \in \mathrm{U}$ the membership function determines the degree of its membership in that set of elements that is formalized by a given fuzzy set. A mathematically fuzzy set is defined as follows:

$$A = \frac{U^{\mu_A}}{u}, \mathrm{u} \in \mathrm{U} \qquad (4)$$

We assume that the risk indicator r is calculated for a specific set of project parameters, taking into account all factors affecting this risk, i.e. the risk indicator is considered as a function of many variables $r = r(a_1, a_2, \ldots . a_k, \varphi_1, \varphi_2, \ldots . \varphi_m)$ where, for example (Astapov, 2015):

- a_1 is the unit cost of production;
- a_2 is the unit price;
- a_3 is the sales volume, etc.

In this case, if the index is calculated for the first parameter, then r_1 is a function of the following factors:

- $\varphi_1$is the decline in production (interruptions in the supply of raw materials, materials, components, marriage due to the fault of workers, marriage due to equipment failure, obtaining poor quality raw materials, materials, components, accidents, natural disasters);
- φ_2 is the production growth;
- φ_3 is the change in prices for raw materials, components;
- φ_4 is the change in price of labor force;
- φ_5 is the change in prices for services of third parties in packing, storage, transportation, sales, etc.;
- φ_6 is the change in taxes;
- φ_7 is the occurrence of inflation or deflationary processes;
- φ_8 is the lack of working capital, which causes loan taking and interest payment;

- φ_9 is the payment of fines, penalties and forfeits.

As a rule, the approach of expert clarification of the risk indicator is practiced focusing on the factors influencing it. For the sake of certainty, let us assume that the risk indicator is calculated considering a certain number of factors affecting it:

$$r = 1 - {}^{a}/_{a^*} \qquad (5)$$

where a is a fixed, planned unit cost of production without risk factors;
a^* is a refined unit cost indicator.

The refined indicator used in formula (5) should be determined by at least two experts. And one Expert Advisor can calculate it taking into account, for example, four factors that affect the cost price, while another Expert Advisor will take into account, for example, nine factors (Abdullaev, Mylnikov & Vasilyeva 2012).

Results

The development of innovation is one of the ways to overcome the consequences of the global economic crisis, both at the national and regional levels. Therefore, scientific research aimed at developing effective methods and means of managing innovative processes are of high practical importance and contribute to the development of the theory and practice of innovation management. The formation of an open expandable information infrastructure for scientific and innovative activities, coupled with the development of methods and technologies for its information and analytical support, largely determine its effectiveness, both within individual territories and in the country as a whole. When assessing the risks of an investment project, it is necessary to take into account the uniqueness of each project, which requires a search for completely new solutions, various applications and a combination of several tools and assessment methods for the effective implementation of the project. In the work, an analysis of the main approach used to determine the likelihood of termination of projects in the field of high-tech innovation was carried out. According to the results of the analysis, the following features of the implementation of the theory of prospectuses were identified:

- application of the “top-down” approach does not increase the degree of probability of taking into account risk factors, which can lead to an incorrect / inaccurate assessment of the risks of termination of projects in the field of innovation;
- approaches based on risk-neutral estimates, as a rule, depend on changes in market prices for various financial instruments. It should be kept in mind that the structural basis of such approaches is based on the principles of an investor's neutral attitude to risks, as well as the significant role of trade in the work of various financial instruments. Therefore, these factors indicate a certain degree of limited risk-neutral approaches when assessing the possible termination of projects in the field of innovation;
- when using expert approaches in practice, it must be remembered that they largely depend on the competencies of the experts themselves. Practical experiments conducted by Daniel Kahneman and Amos Tversky have unambiguously shown that the minds of experts quite strongly exaggerate the values of small probabilities and downplay the values of large and medium probabilities to the same extent.

Conclusions

Innovative projects and processes at all stages are characterized by the absence of a full guarantee of achieving a successful result. The development of innovation in recent years shows that the practice of applying many investment approaches is unpromising. Therefore, in addition to risk assessment, building forecasts and other approaches that are gradually entering into everyday activities when evaluating innovative projects, their support should appear at all stages of the life cycle, which is justified by significant risks of the innovation process. To assess the risk in the implementation of various innovative projects, it is proposed to use the following algorithm:

- get an initial expert assessment, which will include various probabilistic scenarios of a future innovation project;
- determine the weight function, establish its values and make a subsequent assessment, i.e. compose and solve systems of nonlinear equations;
- carry out a final adjustment of the obtained probability values.

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Optimization of the mechanisms of the modern franchise system based on the modification of methods of economic development

Оптимизация механизмов работы современной франчайзинговой системы на основе модификации методов экономического развития

Pavel D. Milovanov[4]

Abstract

The article is devoted to optimizing the working mechanisms of a modern franchise system based on the modification of multicomponent methods of economic equilibrium. In the theoretical part, the formation of an enterprise strategy in the field of franchising is considered, indicating a sequential set of steps necessary for the effective and successful implementation of the ideas included in the franchising project. The development of franchising in Russia is showed and it is noted that it is accompanied by the presence in the new economy of a number of negative factors, in terms of the work of economic mechanisms, as well as legal and social processes. In the research part of the article, the author set the task of modifying the franchise system to establish a certain level of economic equilibrium in it, based on the introduction of certain fines and incentives. In the course of the study, it was found that the franchisor in the franchise system is required to select the amount of fines and incentives in this way that optimal balance is achieved. To solve the problem of optimal equilibrium in a franchise system, it is necessary to bring it to problems that can be solved using linear programming methods. In conclusion, the article discusses the possibility of using franchising tools based on the use of rewards and fines for the successful development and conduct of business.

Keywords: economic balance, franchise system, linear programming, model optimization, system modeling.

Аннотация

Статья посвящена оптимизации механизмов работы современной франчайзинговой системы на основе модификации многокомпонентных методов экономического равновесия. В теоретической части рассматривается формирование стратегии предприятия в сфере франчайзинга, с указанием последовательного набора этапов, необходимых для эффективной и успешной

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реализации замыслов входящих во франчаизинговый проект. Рассматривается развитие франчайзинга в России и отмечается, что оно сопровождается наличием в новой экономике ряда негативных факторов, в части работы экономических механизмов, а также правовых и социальных процессов. В исследовательской части статьи авторами ставится задача провести модификацию франчайзинговой системы для установления в ней определенного уровня экономического равновесия, на основе ввода определенных коэффициентов штрафов и поощрений. В ходе проведенного исследования было установлено, что франчайзер в франчайзинговой системе, обязан подбирать величину штрафов и поощрений таким образом, чтобы достигалось оптимальное равновесие. Для решения задачи оптимального равновесия в франчайзинговой системе необходимо привести ее к задачам, решение которых возможно при использовании методов линейного программирования. В заключение статьи рассматривается возможность применения инструментов франчайзинга на основе использования модели поощрений и штрафов для успешного развития и ведения бизнеса.

Ключевые слова: линейное программирование, оптимизация моделей, системное моделирование, франчайзинговая система, экономическое равновесие.

Introduction

Franchising has been used in the practice of international business for about a hundred years, but it entered to the Russian market in the early 1990s, in connection with the appearance of large foreign companies, many of which successfully work in the service sector. From the point of view of the process, franchising can be considered as one of the ways to deliver various products / services to the final consumer, as well as a definite opportunity to successfully conquer, hold and develop the market through the use of cooperation mechanisms not only of material, but also financial means of various high-tech enterprises. Franchising from the legal side is a certain document, in which it is determined that a legal entity or, for example, an individual entrepreneur, which is the direct distributor of goods / services that are mandatory protected by a trademark, represents certain rights, as a rule that are exclusive in nature associated with the sale in a certain territory of goods or services by another entrepreneur. In exchange, the person who provided these rights has the opportunity to receive a certain percentage of goods / services sold by the entrepreneur, according to the points indicated in the contract, provided that the technological and service processes are not violated or changed. The following types of franchising are distinguished in modern economic literature (Kholin, 2015; Babkin, 2018): franchising in the field of work with goods, of production of goods and of doing business.

In economically developed countries, franchising as one of the effective forms of doing business, based on the principle of interaction between partners, has been established for a long time. Thus, in the USA, the share of companies and enterprises working in the field of franchising, according to leading experts, is about 18.5 million workplaces, which gives about 2.3 trillion dollars of income in the structure of the national economy. Franchising enterprises generate income of 48.56 billion dollars in the national economy of China, with 950 thousand workplaces. According to experts, the spread of national and international brands in the Chinese economy will increase by about 20-25% by the end of 2024.

Literature Review

Recently, there is a trend in Russian business related to the growing interest in the use of franchising as a methodology built on effective, high-quality and rapid expansion of entrepreneurial activity. Franchising seems to be the best way to integrate into foreign and regional sales markets. It allows using the neighborhood of the franchisee to a potential consumer and provides the ability to quite quickly adapt to various changes in the market. The franchisor also receives at its direct disposal highly qualified personnel, including managers in the form of a franchisee. The franchisee has a high personal interest, because he is the owner of the enterprise, therefore, he is more than anyone else interested in revenue growth and expansion of his enterprise, which means that this should favorably affect the performance of the system (Astapov, 2005; Sembieva, Nurtazina, 2016).

The problem of developing a definition of franchising as an organizational and economic mechanism for the development of entrepreneurial activity is significantly complicated by its versatility and the variety of tasks solved with its help. Various authors consider franchising as a tool for the following (Drogobytsky, 2018):

- attracting capital by the trademark owner (it is important to note that there is no concept of “trademark” in Russian law, however, it is widely used in marketing, and therefore in the future we will use it);
- building hybrid enterprises and business virtualization;
- brand transfer;
- building a contractual marketing system;
- organization of mutually beneficial cooperation between large and small enterprises;
- sales outsourcing (for the franchisor) and brand management (for the franchisee), while the relations of sales outsourcing are unregulated and do not require explicit payment by the franchisor;
- refusal to alienate the means of production from the employee;
- formation of a vertically integrated structure.

The strategy of an enterprise in the field of franchising, as a rule, pursues in full measure the achievement of the goals, objectives and principles of effective development of the network, and also helps to determine the necessary sequence of actions that need to be implemented by the company's management in order to fully implement the developed project in the field of franchising. The practical implementation of ideas in a franchise project goes through the following successive stages (Lyudmila, 2017; Dmitriev & Novikov, 2019):

- implementation of work in the field of franchise development planning, which are associated with determining the degree of readiness of an enterprise to conduct business based on a franchise model;
- carrying out work to create a franchise, followed by identification of the most significant parameters included in the developed franchising system, as well as technical work related to the preparation of all necessary legal documentation;
- development of mechanisms for competent promotion of the created franchise to the market;

- calculation of the sale value of the created franchise with the subsequent formation of an integrated franchising network;
- carrying out work aimed at eliminating shortcomings in the developed franchise, through the competent use of accumulated experience related to the opening and operation of enterprises based on franchises.

To develop small and medium-sized businesses, it is necessary to comprehensively support franchising, because a model of doing business in macroeconomic terms will contribute to a qualitative modification of the structure of Gross Domestic Product in Russia, i.e. will shift the emphasis to the emergence at its core of a significant share of small and medium enterprises. Franchising will also allow transforming the macro-social environment, creating new workplaces that will relatively guarantee a stable income, and then to qualitatively modify the social component of the entrepreneur's image (Semicheva, 2016; Dmitriev & Novikov, 2019).

Currently, the share of franchised businesses in the global economy is showing fairly stable and steady growth. According to experts, the number of companies operating in the franchising industry is increasing on average by 1.5-3.5% every year, for example, in the USA there are over 730 000 of such companies. Franchising is developing in Russia slowly, compared to global indicators. Figure 1 shows a graph of the development of franchising in Russia based on the forecast data compiled by experts from the Russian franchising association.

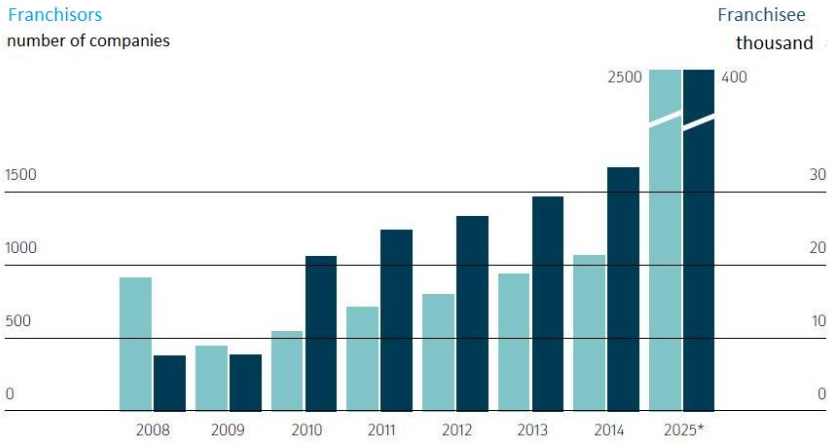

Figure 1. Franchising development in Russia.
(Source: Russian Franchise Association, World Franchise Council (forecast)

These data show a fairly stable growth in the supply / demand market since the beginning of 2010. In the crisis year of 2014 in Russia, already about 1 000 companies are actively working in the field of franchising and more than 30 000 franchisees are already fully operational. Based on the forecast by the end of 2025, we can expect a significant increase in the number of companies, the scope of which is associated with the sale of franchises to about 2 500. The development of franchising in Russia has negative factors in the new economy, in terms of the work of economic mechanisms, legal and social processes. Let us consider in more detail the groups of factors that negatively affect the development of franchising in the Russian business environment (Zemlyanskaya, Mikhailova & Sazonov, 2019; Novikov & Veas Iniesta, 2019):

1. Rather low level of support provided by financial companies operating in the Russian market (VTB Capital (Russian investment bank), Veles Capital Investment Company, Bank Otkritie Financial Corporation, etc.).
2. Inability to obtain the necessary amount of information about the activities of franchisors and franchisees.
3. Unscrupulous activities of a number of franchisees regarding the payment of royalties (cash rewards for the use of franchises, patents, licenses, etc.).
4. Significant flaws in the current laws of the Russian Federation in the field of organizational and legal activities of franchising (legislation does not contain such key concepts as a franchise, franchise agreement, franchising, etc., therefore, all activities are regulated only on the basis of the provisions of Chapter 54 of the Civil Code of the Russian Federation "Commercial concession").

The franchisor's intellectual capital, in turn, is not only the brand, know-how, etc. The intellectual capital contributed by the franchisor as a contribution to the assets of the franchise network includes the following (Akulova, Zykova & Golchenko, 2016):

- combination of knowledge, skills, experience, creativity and leadership competencies that create value in the organization. Although, as a rule, the franchisees and their employees occupy the bulk of the franchise network's participants (i.e., it can be argued that the bulk of the human capital of the network is formed by the franchisee), the franchisor's human capital is crucial for the success of the entire network as a whole. It depends on the management skills of the franchisor and his employees how effective the formation of the network and the coordination of its work will be;
- components of organizational capital (values, philosophy, structure, teamwork, etc.). These terms are in the further formation of elements that logically build the internal institutional environment of the franchise network;
- components of process capital (set of methods, procedures, processes and systems used in the organization when creating value). Using the process capital of the franchisor gives the franchisee the opportunity to significantly increase work efficiency compared to independent enterprises, reducing transaction costs;
- components of innovative capital (intellectual property and other types of intangible property used to create additional value);
- set of established relationships with contractors in the process of the organization.

Methodology

If the existing franchise system has heterogeneous types and groups of resources, we introduce the necessary conventions (Grisko, 2018):

$x_i(i = \overline{1 \dots n})$ is the number of gross products sold by a high-tech enterprise in the franchise group for a conditional calendar period;

$a_{ij}(i, j = \overline{1 \dots n})$ are the coefficients obtained from the direct use of resources calculated on the basis of the *i*-th group, necessary to create a single product included in the group *j*;

$y_i(i = \overline{1 \dots n})$ is the total volume of products sold of the *i*-th group falling on the foreign market within the planned period;

$R_k(k = \overline{1 \dots l})$ is the volume attributable to the type of resources provided by the franchisee under the contract, for the purpose of use in production during the planned period;

$r_{ki}(k = \overline{1 \dots l}, j = \overline{1 \dots n})$ are the coefficients attributable to standard costs that were set by the franchisor for the *n*-th set of resources spent on the production process of one unit of products included in the *j*-th group during the period.

The plan approved with the franchisor and franchisee, which includes various production and sales aspects, as well as a list of services provided in the franchise system, provided that the management structure used is decentralized, can be written as follows (Grisko, 2018; Ananyin, Zimin, Lugachev, Gimranov & Skriprin, 2018):

$$x_i = \sum_{j=1}^{n} a_{ij} x_j + y_i, \ i = \overline{1 \dots n} \quad (1)$$

$$\sum r_{ki} x_j \le R_k, \qquad k = \overline{1 \dots l} \quad (2)$$

It is necessary to determine non-negative values of variables $x_i(i = \overline{1 \dots n})$ at given values a_{ij}, y_i, r_{kj}, R_k, based on the conditions considered in formulas (1) and (2).

In the process of practical work of industries on certain components that are part of the franchise system, as a rule, there are some limited resources R_k in the field of production, i.e. some manufacturing restrictions are imposed, given in formula (2). These manufacturing constraints are significant because the inequality given in formula (2) and the equality in formula (1) may be devoid of a joint solution. Let us explain that in theory there may not exist a production plan at all in which the gross value x_i, subject to the restrictions presented in formula (2) and certain coefficients a_{ij}, r_{kj} able to fully ensure the necessary sales volume of products y_i, which means that the equilibrium of the franchise system in this case is not possible. Therefore, to achieve the necessary balance of the franchise system, provided that it contains additional resources obtained, for example, from sources outside the system, which means that it is necessary to analyze the issue associated with determining the optimal degree of use of these resources. This is necessary in order to qualitatively be able to expand existing production capacities and as a result to ease the set of restrictions presented in formula (2), as well as to be able to fully implement the plan for selling products formed according to the restrictions stated in the franchise. If it is impossible to attract additional resources, then in order to successfully solve the problem of achieving a certain equilibrium level by the franchise system, it is necessary to reduce the problem to the correct determination of the volume of the group x_j (to try to achieve an indicator at which the loss of the franchise system will be the smallest) (Abdullaev, Mylnikov & Vasilieva, 2012; Rasskazova, 2016).

Now we consider the problem of finding the equilibrium indicator in a franchise system, based on the application of the method of rewards and fines.

Here P_i is the planned indicator of profit attributable to the *i*-th group;

$U_i(U_i \ge 0)$ is the indicator of the level of deviation in the volume of products / services sold per *i*-th group y_i from the values of the planned profit indicator in the direction of its reduction;

$V_i (V_i \geq 0)$ is the indicator of the level of deviation in the volume of the sold *i*-th group of products / services of y_i from the values of the planned profit indicator in the direction of its increase;

a_i is the penalty coefficient calculated for each additional unit of negative addition in the implemented *i*-th group of products / services;

β_i is the incentive coefficient calculated for each additional unit of positive addition in the implemented *i*-th group of products / services.

It should be noted that encouraging values in the model are accepted as positive values, and penalty values as negative values, therefore:

$$a_i > 0, \beta_i > 0 \qquad (3)$$

The task of achieving a certain level of equilibrium on the basis of a reward and penalty system in a franchise system is one of the most qualitative and, of course, effective ways to manage a hierarchical system built on a contractual basis (Sazonov, Mikhailova & Kolosova, 2017). Franchisees, within the framework of the signed agreement, will have to pay the established fines, for example, if the number of goods sold or services rendered is less than planned and in turn receive tangible additional remuneration in case of over fulfillment of planned targets. Consequently, the franchise system, as much as possible, seeks to minimize fines for certain product groups and will make every possible effort to increase its total profit in all areas of production (Chinazirova, 2017; Pinkovetskaia, Balynin & Berezina, 2019).

J_1 is the certain set of numbers of the respective production groups, the products of which, after successful implementation, are reflected in the optimal plan and do not exceed the current planned profit P_i, so, J_1 is the definite set of only those values of indices *i* that directly provide the inequality:

$$J_1 = \{i / x_i - \sum_{i=1}^{n} a_{ij} x_i \leq P_i\}, \qquad (4)$$

where x_i is the certain value of the gross output of the *i*-th group in the position of the optimal equilibrium indicator of the franchise system.

We use the same principle and introduce the notation J_2, which will be a certain set of numbers attributable to those manufacturing sectors and services, the implementation of which will allow making a profit that can exceed the planned profit:

$$J_2 = \{i / x_i - \sum_{i=1}^{n} a_{ij} x_i \geq P_i\} \quad i = \overline{1 \ldots n}. \quad (5)$$

With fixed valuesa_i and β_i the amount of income in the optimal plan from profit can be mathematically written as follows:

$$\sum_{i \in j_1} a_i \left(P_i - x_i + \sum_{j=1}^{n} a_{ij} x_j\right). \qquad (6)$$

The size of the promotion recorded in the optimal plan can be written as follows:

$$\sum_{i \in j_2} \beta_i \left(x_i - x_i + \sum_{j=1}^{n} a_{ij} x_j - P_i\right). \quad (7)$$

Consequently, the profit of the franchise system can be written in the form of an expression:

$$\sum_{i\in j_1} a_i\left(P_i - x_i + \sum_{j=1}^{n} a_{ij}x_j\right) - \sum_{i\in j_2} \beta_i\left(x_i - x_i + \sum_{j=1}^{n} a_{ij}x_j - P_i\right). \quad (8)$$

If the values a_i and β_i are fixed, then the franchise system will try to reduce the values of the expression presented in formula (8). This will happen due to the fact that the franchise system bears a certain level of responsibility for various types of fines that may arise due to sales of products below the established norm. The franchise system, which is controlled by the method of rewards and penalties, will actively contribute to the optimal redistribution of franchises between different groups of goods / services (Skripkin, 2017).

Results

As a result of the study, it was concluded that the solution to the problem of the slow development of the finished business system can be carried out, first of all, by improving the legal framework. In particular, to accelerate the development of franchising in Russia, the norms of Chapter 54 of the Civil Code of the Russian Federation and the general provisions of civil law are not enough; it is necessary to develop more detailed legal acts in this area. In addition, it is necessary to conduct training for entrepreneurs who are ready to work in this field, which will allow them to learn the features of concluding a franchising agreement, the basic business schemes in this area and will allow them to also get acquainted with the legal principles of activity. It should be added that it would be advisable to adopt state support programs to attract entrepreneurs to the franchising sphere. The dynamics of the modern world is that the creation and development of a business is impossible without the use of new technologies. The most effective way of organizing a business is to use innovation in various fields of activity together. This is due to the significant one-time costs of starting a business, which in the future will pay off due to the low costs of operating the business.

Conclusions

Now, franchising, of course, can be considered as one of the most promising types of business organization in modern economic conditions, which effectively contributes to solving various problems that most often arise among entrepreneurs, small and medium enterprises. Of course, it should be noted that the acquisition of a franchise and the subsequent expansion of the business through a number of mechanisms laid down in franchising will not work at all if we use its “startups” tool, i.e. when a business is organized from the beginning. As a rule, a franchisor sells franchises only to those companies and enterprises whose activity has existed for a long time and has been successfully developing, and they have some experience in managing franchises. Franchising tools successfully help to develop, for example, retail chains, which in turn enables enterprises to create workplaces that are so needed now, contribute to a qualitative increase in the general culture and significantly strengthen the innovative component of entrepreneurship in the country of presence.

Summing up, we can conclude that now in Russia, franchising is only at the beginning of its development, which is quite far from foreign franchising models due to the scale of their distribution. But it is worth noting that there are great prospects for its further

development, since compared to foreign markets, where there is huge competition in this area, the Russian market with its large population presents enormous opportunities for the development of "domestic franchising".

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