METHODS OF COMPLEX EVALUATION OF THE LEVEL OF COMPETITIVENESS

Viktor Semenov

Saint-Petersburg State Economic University, Russia

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Abstract

Today the important challenge in the evaluation of the competitiveness level in corporations is the definition of rational combination of technical and economic factors in the innovation process. The solution to this problem requires the evaluation of projects based on several criteria which reflect the efficiency, risk and financial stability. That is why it is necessary to apply a multi-criteria approach to the analysis and evaluation of innovations. To do a comprehensive multi-criteria evaluation of projects according to the system of relevant criteria it is advisable to use a complex of particular models followed by the multi-criteria optimization of the decision-making process. This implies a necessity for a multiple-model approach to the analysis of innovations. The use of such approaches to solving extreme problems during the innovation process management opens a possibility of the synergistic effect as a result of the implementation of tasks solved on a multi-purpose base. On the basis of the proposed mechanism, a system of indicators of evaluation of the competitiveness level was developed by a case study of the auto service business. On the basis of a computer modeling study in the concerned range of variation of input and control parameters, it is possible to determine their optimal combination, which, in addition to achieving the required quality of customer service will ensure the maximum profit.

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1. Introduction

The development of the world economy shows that the well-being of the population is highly dependent on the results of scientific and technological progress which appears to be the most important factor of socio-economic development of the modern post-industrial society, the basis of the competitiveness of firms and national economies (Bell, 1999; Genkin, 2009; Glukhov & Okrepilov, 2008; Ivanov, 2011; Porter, 2002; Semenov, 2012).

Scientific and technological progress can be represented as two components: achievements and innovations. The achievements result in a new knowledge, technologies and equipment. The innovations result in a professional bringing of the accumulated knowledge and technologies to the market and their effective use; increase of goods and services sales that determine the well-being of the population. In times of crisis preference is given to innovations. It enables rapid economic advances which lead to investments and growth of welfare of population (Semenov, 2003).

The methodological basis of the modern theory of innovations is the theory of economic development of J. Schumpeter (Schumpeter, 2007). His dialectical approaches did not lose its importance nowadays and are widely used in research work and practice.

Economic aspects of the innovation process in the business sector of developed countries at the beginning of the XXI century were reviewed by a group of Russian scientists (Innovative Economy, 2004). They reviewed the various classifications of innovation and noted two different approaches to the division of innovation based on their underlying causes. The causes can be either a "technological impulse" or "demand challenge". Based on them the innovations are divided into

"innovations of offer" and "innovation of demand". Thus, some researchers (Schumpeter, Friedman, Rosenberg, Nelson, Phillips and others) believe that the causes are the scientific and technical conditions. Others (Schmookler, Mensch, Vonhippel) believe that the determining factor is the demand and the innovations are related to the process of commercialization. This suggests the nonequivalence of different types of innovations.

On the basis of the observed differences it is possible to conventionally determine the ratio of the technical and economic factors in the innovation process. Studies show that at the present time there is an ever-increasing interaction between technical and economic factors (Innovative Economy, 2004), the search for a rational combination of which is a central task of managing the entire process of innovation (Zavlin, 2001; Semenov, 2003).

One can not but agree with the authors of the monograph (Innovative Economy, 2004), claiming that the life cycle of innovation as a process is defined by its technological and economic potentials.

Technological innovation potential associated with objective physical, chemical, biological and other boundary parameters. At every instant, it is determined by the gap between the achieved level of technical efficiency and theoretically possible limit of the technology efficiency. In this case, the measurement of technical efficiency or technical level is based on the parameters, that are of the greatest use-value to the potential customers or consumers, and is not purely related to technical achievements. There are numerous examples of calculation of the efficiency of research and development, in which the "product" is considered to be a technical growth level (Dynkin, 1991). These examples testify the rise of A high-tech engineering level. Technological efficiency of research and development can be defined as the ratio between the increase in the technical level and the invested resources.

Technical efficiency is a necessary but not sufficient condition for the commercial success of the innovation. Efficiency of the innovation is the product of both technical and economic efficiency.

The efficiency of innovation is positive, if both its components have a positive value. When technological innovation has high efficiency, but meets no demand, its overall efficiency is negative. Similarly, the expansion of the production at the same technological base in a dynamic competition will lead to negative results, because the use-value of the product will begin to decline as a result of competition, and as a result of saturation of demand.

The purpose of this article is to analyze the main issues assessing the level of competitiveness on the basis of the interaction of technical and economic factors of the innovation process in business in the modern world.

The subject of the paper are the methods for the integrated assessment of the competitiveness level in corporations which form the basic level of national innovation systems.

2. Method

Innovative investment is formed both by its own and borrowed sources of funding. And for the financing of innovation firms are in dire need of attracting a significant amount of borrowed and raised funds. Therefore, the management of the innovation process at the present time can be considered as activities aimed primarily at ensuring the most effective investment of funds in innovative projects and obtaining of expected results.

With their design and performance evaluation it is necessarily to consider that innovative investments are characterized by high risk. In their structure, the leverage ratio is generally high, including bank loans and financing sources of a targeted development program for promising areas of science and technology. Reimbursement of costs in the first use of investment may not be that significant. However, the innovative investments have a significant impact on a competitive strategy and pricing policy of the company, allowing making fundamentally new types of products.

At the heart of the investment decisions there is always the assessment and analysis of the efficiency of the expected future cash flows that arise from the implementation of the project.

Model of the investment process in the entrepreneurship should reflect not just the amount of the investment flowing to the projects, but also should allow the adequate assessment of the expected change in the cash flows of firms in each year of the calculation period for certain activities. Selection of projects should be based not only on firm's efficiency criteria, but also on criteria reflecting the stability of their financial position during the period of investment. To assess the financial strength it is necessary to consider all the financial flows associated with the investing, since the creation of innovation should be carried out both by the use of own and borrowed funds.

The implementation of innovative projects should provide a given level of profitability, the acceptable level of risk and the stability of the financial position of firms in the investment period. Therefore, the evaluation of the projects should be based of several criteria reflecting the efficiency, risks and the financial stability of enterprises. Methodologically, the use of multi-criteria approach to the analysis and evaluation of innovative projects would be necessary (Steuer, 1992).

For the implementation of a comprehensive multi-criteria evaluation of projects on the system of criteria it would be appropriate to use a set of partial models, followed by multi-criteria optimization of the decision-making process. Methodologically, this means a shift to polymodel principle of comparative analysis of variance for innovative projects.

Logically, the essence of the Multiple-evaluation and construction of a corresponding complex model for certain alternatives of innovative projects is reduced to an adaptive design and conceptual substantiation of the methodological provisions of a multivariable evaluation. Additionally it should be considered and taken into account the specific properties and conditions of the assessment.

3. Results

In our opinion, organizational-economic mechanism of evaluation and selection of effective innovative projects should consist of the following main units (Semenov, 2006):

- technology evaluation of the projects;
- evaluation and taking of investment decisions;
- assessment of regional (network, corporate) interaction of business structures;
- comprehensive evaluation and selection of projects.

Multiple-evaluation of investment decision involves a complex structure of the general model of evaluation and decision-making, which consists of a number of particular models to perform multidimensional analysis of the options and then making the decision taken on the basis of the criterion of preference in the process of multi-criteria optimization. Thus, the unit of evaluation and taking of investment decisions includes the following models:

- A model of economic and financial evaluation of projects;
- Corporate evaluation model for projects;
- Evaluation model of investment risk;
- A model of multi-criteria decision analysis based on designed criteria of preference.

The first three models can be seen as a partial model, and the model of multi-criteria analysis and decision-making - as a general model for the optimization of investment decisions.

Algorithm of finding the desired solution consists of several stages. First Multiple evaluation of project is carried out with the aim of redefining the problem of optimizing choice of a preferred embodiment of the project according to relevant criteria, taking into account technical and economic factors. The next step is the adoption of multi-criteria optimization of decision making. At this stage the aggregation of criteria for project evaluation, and expert multi-criteria evaluation of alternative projects are made. A final decision on the choice of a preferred embodiment of the project is taken at the final stage of the algorithm.

The objectives of management of the innovation process, thus, require the use of methods of multi-criteria decision making. In a sense, they are often the generalization of one-criterion methods. However, most of the management decisions are aimed at achieving the objective of several, often conflicting, goals; it is difficult to reduce the problem of finding the optimal solutions

to the classical one-criterion methods. Therefore, in recent years a lot of attention, both in theoretical and in practical aspects on the development of new methods for evaluation and optimization of management decisions [remove: in the first place], was focused on the theory of fuzzy sets (fuzzy logic).

Apart from these, along with the calculus of variations, the solution of differential equations, linear programming Pareto optimization techniques are used, as well as finding the planes of indifference, etc.

among the diversity of the existing multi-objective optimization methods we can point the highly effective and relatively widely used in practice method of the parametric scalarization of vector criterion methods based on algorithms from the so-called "family fold". These include uniform methods of optimality, a fair compromise, guaranteed result, etc.

During the economic analysis of projects the attention should be paid to the methodological support and the use of software tools for the information support. Methodological apparatus of implementation includes analytical methods, simulation, situational modeling, expert analysis, qualitative methods of system analysis, etc.

4. Discussion

On the basis of the proposed mechanism it was designed a scorecard assessing the level of competitiveness and quality on the example of the auto service business.

Competitiveness and quality of modern products, and production processes are determined by a combination of hundreds and often thousands of individual performance of their properties.

At the same time, methods used for a comparative evaluation were proposed more than 20 years ago, those are the qualitative methods such as differential, integrated and combinations of them (Fedyukin, 2009). The essence of these methods is that out of a plurality of indicators with different meaning, nature of effect on quality and physical nature of the indicator by simply adding them, a composite index is created, based on which estimation is made on.

There are a large number of firms, for which, by the ever-changing production and the lack of technical documentation the most effective evaluation method is the competence approach (Larichev & Moshkovich, 1996). The main nonformalised method is based on the results of the expert evaluation.

The main methods of evaluation of the results of expert studies, their advantages and disadvantages are shown in Table 1.

Table 1. Advantages and disadvantages of the main methods of evaluation of the results of expert studies of competitiveness and quality

Name	Advantages	Limitations
The method of paired comparisons	The selection is made from only two alternatives	Insufficient amount of information to obtain reliable estimates
Group Method of estimation	Competence of the experts is characterized by means of the weight of indicators	Higher complexity of the process of obtaining the evaluation
The method of multi-comparison	Estimation using summary measures, represents the aggregate of the most important properties of an object	The complexity of selection criteria, the totality of which should display the list of properties of an object to select the best
The method of arithmetic rank	Prevalence, ease of calculation (a minimum of mathematical operations)	The results are often not adequate and contradictory
The method of median ranks	Allows you to average the data as accurate as possible in an ordinal scale	Ranking number is necessary, which increases the complexity of estimation
Matching method of cluster rankings	This lets you put the contradictions in clusters, which corresponds to the ordering of all the original orderings	The complexity and the number of used mathematical operations entail an increase in the resource base

Since part of the performance are the results of their ranking by experts, on the basis of the rules of statistics non-numeric objects of nature (which include rankings) the application of arithmetic operations to them is a gross mathematical error (Orlov, 2004). In addition, as a result of adding the values of different dimensions, we obtain the expression, devoid of real meaning.

Quite often there is a situation where the growth of the numerical values of the index, reducing the quality (e.g., complexity of equipment repair) still leads to an increase in the value of the final level of quality. In this case, the methods for multi-criterion (multi-factor) analysis of the competitiveness and quality of products can be used. They have been proposed in several papers in the frame of the development of a methodology for constructing optimal quality management systems (Vinogradov & Burylov, 2009; Vinogradov, Semenov & Burylov, 2013).

In particular, based on the conclusions of the theory of representative measurements and statistics of non-numerical nature objects (Orlov, 2004), the method of harmonizing contradictions between cluster rankings is used, rating the quality of the objects being compared, as well as finding the Kemeny's median (Vinogradov, Semenov & Burylov, 2013).

Calculating the Kemeny's median is produced by integer programming. In particular, for its finding discrete mathematics algorithms are used, based on the idea of random search.

As the experience of using the developed method has shown (Vinogradov, Semenov & Burylov, 2011), in case of use of more than ten investigated parameters, there are considerable mathematical difficulties of solving such problems. Difficulties arose also due to latency of numerous variables in studied models.

Significant reduction of the number of model parameters of the optimal quality management system (sometimes up to two orders of magnitude) can be done through the use of projective mathematical analysis methods, in particular, the principal component method (Pomerantcev & Rodionova, 2002).

For the purpose of the proposed method of testing the objectives, the criteria and parameters for auto service businesses were identified. Detailed expenses of car-care center were described and a table of influence of various factors on the resulting performance was build.

A computer modeling study using the range of variation of input and control parameters of our interest has determined their optimal combination, which, in addition to achieving the quality of customer service, led to obtain the maximum possible profit.

References

Bell, D. (1999). The coming post-industrial society: the experience of social forecasting. Moscow. Academia.

Vinogradov, L. V. & Burylov, V. S. (2009). Perspective directions of mathematical models of quality management systems. Quality Management: Issues, research, experience. Issue 6. St. Petersburg. SPbGIEU, 32-39.

Vinogradov, L. V., Semenov, V. P. & Burylov, V. S. (2011). Economic-mathematical methods in quality management. St. Petersburg. SPbGIEU.

Vinogradov, L. V., Semenov, V. P. & Burylov, V. S. (2013). Means and methods of quality management. Moscow. INFRA-M.

Glukhov, V. V. & Okrepilov, V. V. (2008). Managing the quality of life. St. Petersburg. Science.

Genkin, B. M. (2009). The grounds of economic theory and methods of effective work. Moscow. Norma

Dynkin, A. (1991). A new stage of scientific and technological revolution: the economic content and implementation mechanism in a capitalist economy. Moscow. Science.

Zavlin, P. N. (2001). Innovation activity in the modern world. *Innovation, 8, 13-16.*

Ivanov, V. V. (2011). An innovative paradigm XXI. Moscow. Science.

Innovative Economy (2004). Moscow. Science.

Larichev, O. I. & Moshkovich, E. M. (1996). Qualitative methods of decision-making. Moscow. Science

Orlov, A. (2004). Non-numeric statistics. Moscow. Press.

Pomerantcev, A. L. & Rodionova, O. E. (2002). Multivariate Statistical Process Control. *Methods of Quality Management, 6,* 15-22.

Porter, M. (2002). Competition. Moscow. Publishing house Williams.

Semenov, V. P. (2003). The problems of innovation and investment process. *Innovation, 8,* 48-50.

Semenov, V. P. (2006). The interaction of scientific, technical and economic factors in the innovation and investment process. *Proceedings of the ETU "LETI" (Economics and Management Organization), 2,* 25-32.

Semenov, V. (2012). National competitiveness and quality of life. *Economics and Management, 17 (2), 567-571,* doi 10.5755/j01.em.17.2.2183.

Fedyukin, V. K. (2009). Qualimetry. Measuring the quality of industrial products. Moscow. KNORUS.

Steuer, R. (1992). Multi-criteria optimization: theory, computation and applications. Moscow. Radio and Communications.

Schumpeter, J. A. (2007). Theory of Economic Development: Capitalism, Socialism and Democracy. Moscow. Eksmo.