



Planning of Technological Development of New Products and Its Impact on the Economic Performance of the Enterprise

**Natalia N. Kulikova^{1*}, Vitaly M. Smolentsev², Alexey I. Tikhonov³, Vasiliy S. Kireev⁴,
Varvara A. Dikareva⁵**

¹Moscow Technological University, Moscow, Russian Federation, ²Kuban State Agrarian University, Krasnodar, Russian Federation, ³Moscow Aviation Institute (National Research University), Moscow, Russian Federation, ⁴National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow, Russian Federation, ⁵National Research Moscow State University of Civil Engineering, Moscow, Russian Federation. *Email: karpuxinanatasha@yandex.ru

ABSTRACT

The market economy is characterized by competition of enterprises, defining the upgrade of production. Improvement of the economic activity of industrial enterprises implies development of new methods, forms and mechanisms of creation and mastering of new competitive products designed to ensure the predominant position of enterprises on domestic and foreign markets. Modern approaches to the creation and development of new competitive products high-tech, require a huge amount of costs. But on the other hand it is the development of new products allows companies to survive in the current competitive environment. Planning for new products refers to the section of strategic planning. Therefore, the ability of the company to develop and introduce to the market its new product depends on its financial performance. A necessary step in production planning is the development of new products, representing a diverse set of processes and activities in the process which is carried out inspection and testing of structures and technologies to specified technical requirements, development of new forms of organization of production. During the development of new products are achieved the planned production volumes, scheduled economic indicators and technical and economic parameters of products. The period of development of new products begins with production of a prototype and ends with serial production.

Keywords: Innovation, Innovation Economy, Economic Indicators, New Products, Development of Production

JEL Classifications: O14, O21, O32, O33

1. INTRODUCTION

The relevance of the work is obvious, as in the modern market in a tough competitive environment, the organization of development of new products is one of the key factors in the functioning of the enterprise. By evaluating such projects developed the overall strategy of the enterprise and the more effective arranged organization of production, including the greater efficiency has the project, the more efficient activity of the enterprise on the market, and therefore higher competitiveness.

Development of production is the initial period of production, starting with the first release of products and ending with the

achievement of project technical and economic indicators (design output of products per unit of time, project complexity, project cost). This period is characteristic for batch and mass type production, where the product range is stable over time. The length of this period may vary from several weeks to several years.

Theoretical and methodological basis of research were the works of leading domestic and foreign experts, dedicated to the theory of innovation, production planning and development of new products.

The study was based on the methods of scientific abstraction, analysis and synthesis, grouping, comparison and classification.

2. PRODUCTION PLANNING AS PART OF PRODUCTION CONTROL

Production planning is an integral part of enterprise management and can be defined as the ability to anticipate the goals and results of the actions of the subject of the economy and determine the resources needed to achieve specific goals.

Any production plan must be based on scientific principles, under which understand the basic theoretical principles that guide the company, its employees in the planning process. They determine the direction and specific content of the planned work at the company (Melamed, 2001; Melamed and Trembovolsky, 2002; Sergeev, 2008; Shadova et al., 2016).

The principle need of planning means widespread and mandatory use of when performing any type of work, since its absence is accompanied by incorrect maneuver; late change of orientation, which is the reason for the failure of the project.

The principle of continuity is that, first, planning for the enterprise should be carried out continuously, without interruption, and, second, what plans should organically come to replace each other.

The principle of unity lies in the systematic planning process in the enterprise. The concept of system implies the existence of a set of elements, relationships between them, the existence of a single direction of development of the elements of the system, focused on common goals. In other words, the unity involves the development of a consolidated plan economic development enterprise, which involves separate plans for its services and divisions, consistent with the general plan.

The principle of flexibility was to make plans and the whole planning process of the ability to change its direction in connection with unforeseen changes in internal or external.

The principle of accuracy is to ensure that the developed plan should be drafted with such a degree of accuracy that is available for businesses at the moment and which is sufficient to solve problems. The lower the planning level the greater the degree of accuracy.

The principle of participation means that every element of production activities, each business unit becomes a member of the planning regardless of the functions performed, i.e., the planning process attracts all those whom it affects directly.

The principle of the validity of the goals and focus on the end result of activities focuses on the fact that, on the basis of the systematic nature of planning, all members of the enterprise have a common ultimate goal, which is a priority. In this case, the company needs to choose the leading units which have greater influence on the end result, and strive to implement them in the first place (Aliyev, 2003; Garfinkel, 2013).

In planning are widely used General principles such as scientific character, system, complexity, optimality, priority, objectivity,

concreteness. The main methods of plan development include the following.

Regulatory method: The enterprise in the planning process applies a unified system of norms.

Balance method: Provides linkages between resource needs and the sources of their coverage by balancing production capacity, working time, material, energy, financial and other, and between the sections of the plan.

The settlement-analytical method: Is used to calculate the indicators, analyze their dynamics, and factors that provide the necessary quantitative level. In this method is determined the base level of the main indicators of the plan and their changes during the planning period due to the quantitative influence of the main factors are indices of changes planned performance compared to the baseline.

Economic-mathematical methods allows to develop an economic model of the dependence of performance on the basis of detection of changes of their quantitative parameters in comparison with the main factors to prepare several plan options, and choose the best.

Graphic-analytical method allows to depict the results of the economic analysis of the graphic means. With the help of graphs revealed a quantitative relationship between paired variables, for example between the rate of change of capital productivity, capital-labor ratio and labor productivity (Silnov and Tarakanov, 2015). Kind of grapho-analytical methods are network diagrams, which simulated the parallel execution of works in time and space for complex objects, such as revamping, development and mastering of new machinery etc.

Programmno-target methods help to make a plan in a program, i.e., a set of tasks and activities, United by one (general) target and time-bound. The program is characterized by a focus on achieving outcomes through specific performers who are endowed with the necessary resources (Novitsky et al., 2008; Chuev and Tchetchevitsin, 2009).

Generally, when planning at the enterprise are used simultaneously than any single method, and their entire range.

Preparation of a new production may be at the time of formation of the company or during the transition to new products. New products are a necessary condition for the survival of enterprises in a competitive environment. Technical preparation of production - is a set of interrelated processes that ensure design and technology - readiness of the enterprise for release of a new product required quality level in the time frame, production volume and cost (Gruzinov, 2002; Dwarf and Shuhgaltera, 2007).

Life cycle of a new product can be represented by the following stages:

- Scientific research, including fundamental, theoretical, applied;
- Development submitted design documentation, prototypes and testing works;

- Technological training, which includes design and development of technological processes, design and development of technological equipment, organization of production, calculation of duration of cycles, amount of, groundwork;
- Of products, which provides savings in materials and fuel and energy resources, reduce the labor intensity, improve product quality, improve product design and manufacture technology;
- The operation of the products subject to extension of product life, reduce costs to operate the equipment and to obtain economic benefits;
- Product disposal, including a decrease in disposal costs of goods and environmental protection.

Based on the stages of the life cycle of a new product preparation new production may include the following operations:

- Conducting applied research related to the improvement of equipment, technology, composition of materials, organization of production;
- The development of new products and development of new technological process of production;
- Logistics the new production, including the purchase of special equipment;
- Training, retraining and advanced training;
- The development of norms and standards, production and organizational structure of management, and information management.

The above elements reflect the three stages of development of the new production: Design, technological (Silnov, 2016) and organizational-economic training.

Design preparation consists of developing the project specification and preliminary design; fabrication and testing of a prototype; development of technical and working projects (Zakharov et al., 2016); the manufacture and testing of pilot batches; debugging designs according to test results; the working of the project and transferring it services technology training (Klochkova et al., 2014).

Technological training is to develop a technology process (technology), which is a consistent change in the shape, size, properties of the raw material for the purpose of receiving products in accordance with specified technical requirements. Technology of production methods, technical means and methods of making products or performing the prescribed work (for example, transportation), the manufacture of the product under specific conditions (Lomonosov, 2002; Turovents et al., 2008; Borisova et al., 2014).

The organization of technological preparation at the enterprise is vested in the office of the chief technologist (OCT) and technology Bureau of the shops; their functions change depending on the degree of centralization of the system of technological preparation of production. So, with the centralized system OCT performs all types of work for the technological preparation and technological Bureau is vested solely in the implementation of designed processes. In a decentralized system OCT performs only General methodological and technological Bureau in addition to

the introduction of the designed technological processes for all kinds of works on technological preparation of production. When a mixed system of OCT in addition to the General methodological guidance performs typing processes and alignment of tooling and technology Bureau is engaged in the standardization of labor operations, material parts, manufacture of special tooling and equipment, development and technological route card (Skvortsova and Nekrasov, 2003; Galevskiy et al., 2016).

In parallel and in close connection with the design and technological preparation is carried out organizational and economic training of new production. It provides for the development of the project organization of the main and auxiliary production, labor and wages as well as standards for planning design and technological preparation. Here is developed the estimated costs for preparing the production of a new product (Petrovich and Atamanchuk, 2012; Fahutdinov, 2010).

Thus, every enterprise is constantly going on a process of development of new competitive products, which is a necessary condition for the survival of the enterprise in the conditions of market economy. Therefore, the preparation of the new production is given much attention and a thorough economic study of the effectiveness of the proposed solutions, which is reflected in the business plan of the company (Rudenko, 2009).

3. CHARACTERISTICS OF THE DEVELOPMENT OF PRODUCTION

In a single trade the period of development is virtually absent, because the update of the nomenclature associated with the release of each new single product or small lot.

The period of development:

1. A significant number of engineering changes, which requires not only the adjustment of the technical documentation, but also change already mastered manufacturing operations, manufacturing equipment, and sometimes processes in General (Shkurkin et al., 2016);
2. The need to acquire working skills, the development of a rational labour techniques in changing production and technical conditions;
3. The achieved level of preparedness of the enterprise to the development of new products.

The above noted features of the period of development are manifested ultimately in the technical and economic indicators of the enterprise: The length of this period and pronounced dynamism in production costs - labor intensity, material consumption, cost (Ilchenko and Kuznetsova, 2003).

4. THE ORGANIZATION OF TRANSITION TO NEW PRODUCTS

There are three main methods of transition to the new products:

1. Consistent;
2. Parallel;
3. Parallel-to-serial.

1. Sequential method of transition - the production of new products starts after the complete cessation of production to be discontinued.

You can select 2 options for this method: (a) continuously-consistent, and (b) continuously-consistent.

- a. Continuously-consistent option: After discontinuing the old product 1 in the same production areas are redevelopment and installation of technological equipment and vehicles (over ΔT), and on completion the development production of a new product 2 (Figure 1). T - minimum stay of proceedings during which no release as the product 1 and product 2.

Advantages: The easiest option for the transition in organizational and technological terms.

Disadvantages: High losses in total output. During ΔT , though lacking the production costs are incurred (specific fixed costs), which will be credited to the cost of mined product.

- b. Continuous-sequential version - release mined product starts immediately after discontinuing the products to be discontinued, i.e., $T = 0$.

Conditions:

1. Requires a high degree of completeness of works on TPP of a new product to the beginning of its development (80% of technological processes, up to 95% of installed equipment);
2. For mass production:

- a. The presence of a backup (or additional) production areas to prepare for the release of a new product or;
- b. High level of integration of new and old products (then you can do without significant use of reserve (additional) space);

For mass production: High level typing apply technological processes and technological equipment.

2. A parallel method of transition gradual replacement of discontinued products newly developed. Simultaneously with the decline in production older model is the growth of new products (T - value time interval combination).

Advantages: A significant reduction (and in some cases total elimination) of losses in the total production output during the development of a new product (Figure 2).

- a. Line 3 - total production of products (to be discontinued and reclaimed) remains unchanged, at least - not decreasing.

Conditions:

1. Additional production work because of the higher complexity of developing products compared to the discontinued,
2. The increase in production capacity of the enterprise; In the absence of these two conditions - option.
 - b. In which the total output is somewhat reduced during the development of a new product. But to decrease the overall issue can be avoided with a high level of unification of the model and develop products;
 - c. Parallel phased (non-stop) option - the upgrade process of the manufactured products is performed in several stages, during which the company starts making so-called hybrid or transitional models. Transitional model differs from previous models with design of individual units, units, elements and blocks.

At each step updates only selected constituents of the products.

Advantages: (1) Don't need radical reconstruction of the enterprise, (2) Uniform output at each stage, (3) Reduce the cost of development of production.

Disadvantages: Lengthening the update process manufactured products (hence the premature obsolescence of new products).

3. Parallel-sequential method is characteristic of mass production in the development of new products, significantly different in design from the subject (Figure 3).

Conditions:

1. Created additional capacity (sections, workshops), which begins the development of a new product;
2. Validation processes;
3. The qualifying training; (4) the organization of the first batch of new products.

During the initial period T in parallel:

1. Continued production of product to be replaced;
2. Development of production of other areas.

After an initial period T_n - short stop in the main production, and other areas for redevelopment equipment: The equipment of additional stations is transferred to the main production shops. Upon completion of these works organized the production of new products.

Disadvantages: (1) the loss in total output during the suspension of production at the beginning of the subsequent period of the development of a new product in the shops; (2) require additional (reserve) space for temporary sites.

Figure 1: (a,b) Sequential method of transition - the production of new products starts after the complete cessation of production to be discontinued

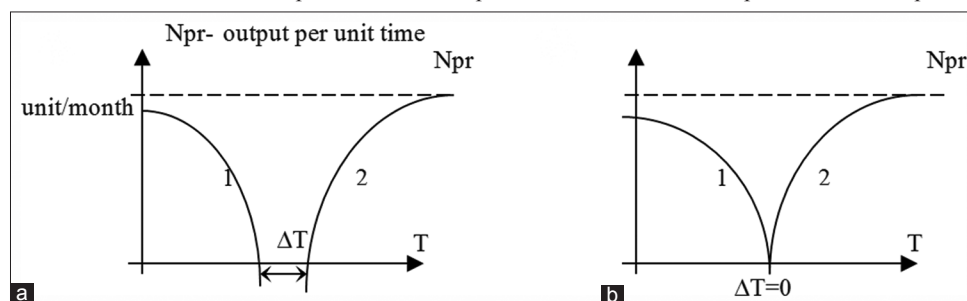


Figure 2: (a,b,c) A parallel method of transition gradual replacement of discontinued products newly developed

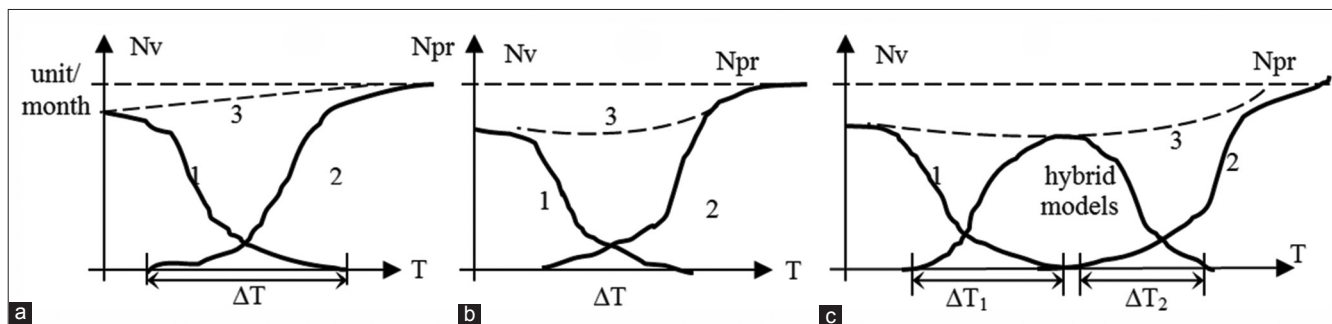
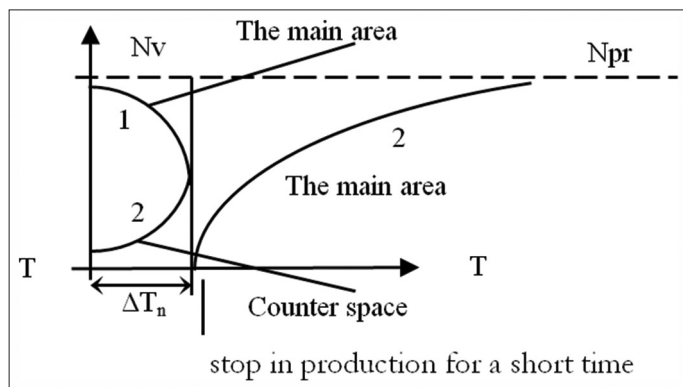


Figure 3: Parallel-sequential method is characteristic of mass production in the development of new products



Advantages: Conducting the initial stages of development on additional (temporary) sites ensures high rates of increase of release of a new product.

You must always provide for the conditions and minimize the losses. But not a single recipe: For complex products mass production - in parallel-sequential method of transition might be the best, and for simple, with a high degree of unification - even consistent.

5. NET PRESENT VALUE

This method is based on comparison of the value of the initial investment (IC) with a total sum of discounted net cash revenue generated by it during predicted term. Because the cash flow is distributed in time, it is discounted using a ratio r set by the analyst (investor) independently based on the annual percent of return which he expects to receive on the invested capital.

For example, it is forecast that the investment (IC) will generate over n years, the annual income of P_1, P_2, \dots, P_n . The total accumulated amount of the discounted incomes (PV) and net present effect (NPV) are calculated respectively by the formulas:

$$PV = \sum_k \frac{P_k}{(1+r)^k}, \quad NPV = \sum_k \frac{P_k}{(1+r)^k} - IC$$

It is obvious that if: $NPV > 0$, project should be taken;

$NPV < 0$, project should be rejected;

$NPV = 0$, the project neither profitable, nor unprofitable.

If the project involves not a one-time investment, and the sustained investment of financial resources in a period of m years, then the formula for calculating NPV modifiers as follows:

$$NPV = \sum_{k=1}^n \frac{P_k}{(1+r)^k} - (I_0 + \sum_{j=1}^m \frac{IC_j}{(1+r)^j})$$

6. INTERNAL RATE OF RETURN

Under rate of return investments (IRR) understand value of factor of discounting at which the NPV of the project equal to zero: $IRR = r$, at which $NPV = f(r) = 0$. The calculation of this factor in the analysis of efficiency of planned investments is as follows: IRR reveals the maximum allowed relative level of costs that may be associated with the project. For example, if the project is fully financed by commercial Bank loans, the IRR value shows the upper limit of acceptable level of Bank interest rates, the excess of which makes the project unprofitable.

In practice, every company finances its activities, including investment, from a variety of sources. As payment for the use of advances in the activities of the company the financial resources it pays interest, dividends, fees, etc., i.e., bears some reasonable costs for maintaining their economic potential. Measure of the relative level of these costs can be called the "price" of the advanced capital (CC, capital cost). This figure reflects the enterprise a minimum return on the invested in his work capital, its profitability and is calculated by the formula weighted arithmetic mean. The economic meaning of this indicator is as follows: The company may make any decisions of investment character, the level of profitability of which is not below the current value of the CC index (or the price of the source of funds for this project if he has the target source). It compares the IRR rate calculated for a specific project, the connection between them is.

If: $IRR > CC$. the project should take;

$IRR < CC$, then the project should be rejected;

$IRR = CC$, the project neither profitable, nor unprofitable.

The practical application of this method is complicated, if the analyst lacks a dedicated financial calculator. In this case, applies the linear interpolation method. For this purpose, the tables are selected, two values of the discount factor $r_1 < r_2$, so that in the interval (r_1, r_2) the function $NPV=f(r)$ changed its value from “+” to “-” or “-” to “+”. Next, apply the formula:

$$IRR=r_1 + \frac{f(r_1)}{f(r_1)-f(r_2)} \times (r_2-r_1)$$

The accuracy of calculations is inversely proportional to the length of the interval (r_1, r_2) and the best approximation using the tabulated values is achieved in the case when the length of the interval is minimal (=1%), i.e., r_1 and r_2 next to each other the values of the discount factor.

7. CONCLUSION

The technological process is the basis of any production process, is a crucial part associated with processing raw materials and turning it into finished products. The development of technological processes, as well as their major technical and economic indicators and the construction of technical systems take place in accordance with specific regularities.

One of the main and most effective ways to reduce costs in the production process is to optimize the production plan of final products. An effective plan will reduce the downtime of both equipment and personnel. A well-crafted plan allows you to get rid of constant stress, breakdowns of sales plans through the fault of the production, to reduce the lead time production orders, optimize inventory balances and production process to make more transparent and manageable.

The relevance of the chosen topic is that planning technological activities of the enterprise and its optimization is a very common problem, especially at the moment. Optimization of the system for technological planning in the organization is the complex of decisions and actions within a particular organization and in accordance with the desired goals contribute to the regulation of its production flows.

The main planning objective is to ensure service managers and the whole enterprise a certain kind of information required for effective resource management. The planning system aims to narrow the scope of uncertainty, which is characterized by the presentation of upcoming events and their consequences.

Summing up the conducted research, we can formulate a number of conclusions:

1. Every enterprise is constantly going on a process of development of new competitive products, which is a necessary condition for the survival of the enterprise in the conditions of market economy. Therefore, the preparation of the new production is given much attention and a thorough economic study of the effectiveness of the proposed solutions, which is reflected in the business plan of the enterprise.
2. Production planning is an integral part of enterprise management and can be defined as the ability to anticipate the

goals and results of the actions of the subject of the economy and determine the resources needed to achieve specific goals.

3. Methodology of economic substantiation of new products is based on the gradual analysis and forecasting of techno-economic parameters under the current production program. To calculate the production capacity, you must have the following initial data: The planned Fund of working time per machine; number of machines; capacity of hardware; complexity of the production program; the achieved percentage of completion standards.
4. When you evaluate the actual efficiency you should consider the impact of new technology not only in basic production operations, but also on preparatory and related work. It is also necessary to consider the impact on capital and operating costs in non-production sectors and the impact on the environment.

REFERENCES

- Aliyev, V. (2003), HTP and Production Preparation. Moscow: Economics.
- Borisova, A.A., Kalyakina, I.M., Bondarenko, N.Y. (2014), Development of methods of the solution of management problems in social and economic systems. *International Business Management*, 8(6), 348-352.
- Chuev, I., Tchetchevitsin, L. (2009), *Enterprise Economy*. Moscow: Finance and Statistics. p268.
- Dwarf, A., Shuhgaltera, M. (2007), *Business Economics*. Moscow: INFRA-M. p563.
- Fahutdinov, R. (2010), *Production Company: Textbook*. 3rd ed. Moscow: INFRA-M. p544.
- Galevskiy, G.V., Rudneva, V.V., Galevskiy, S.G., Il'Yashchenko, D.P., Kartsev, D.S. (2016), Nanosized borides and carbides for electroplating. Metal-matrix coatings: Specifications, performance evaluation. Paper Presented at the IOP Conference Series: Materials Science and Engineering, 125(1), 12032-12036.
- Garfinkel, B. (2013), *Business Economics*. Moscow: Unity. p663.
- Gruzinov, V. (2002), *Business Economics (Business): A Textbook for High Schools*. 2nd ed. Moscow: UNITY-DANA. p795.
- Ilchenko, A., Kuznetsova, I. (2008), *The Organization and Planning of Production: Textbook. Tool for Students*. 2nd ed. Moscow: Publishing Center “Academy”. p208.
- Klochkova, E., Platonov, T., Kuznetsov, V. (2014), *Business Economics*. Moscow: Yurayt. p448.
- Lomonosov, V. (2002), *Managing the Transition Processes in the Manufacturing Industry*. Moscow: Engineering.
- Melamed, G. (2001), *Economy of Production of the New Technology*. Moscow: Economics.
- Melamed, G., Trembovolsky, B. (2002), *The Development of New Products*. Minsk: Belarus.
- Novitsky, N., Gornostay, L., Goryuschkin, A. (2008), *The Organization, Planning and Production Management*. 2nd ed. Moscow: KNORUS. p320.
- Petrovich, I., Atamanchuk, R. (2012), *The Production Capacity of the Economy and Enterprise*. Moscow: Unity-Dana. p372.
- Rudenko, A. (2009), *Business Economics: A Textbook for Economic High Schools*. Minsk: CHIUP. p308.
- Sergeev, I. (2008), *Enterprise Economy*. Moscow: Finance and Staten Stick. p253.
- Shadova, Z.H., Gurianov, P.A., Fedorova, S.N., Zemlyakova, A.V., Grishchenko, O.V. (2016), The structure of the share capital and the interests of the majority shareholder. *International Journal of Economics and Financial Issues*, 6(1S), 211-219.

- Shkurkin, D.V., Ryazantsev, S.V., Gusakov, N.P., Andronova, I.V., Bolgova, V.V. (2016), The republic of Kazakhstan in the system of international regional integration associations. *International Review of Management and Marketing*, 6(6), 174-179.
- Silnov, D.S. (2016), An analysis of modern approaches to the delivery of unwanted emails (spam). *Indian Journal of Science and Technology*, 9(4), 1-4.
- Silnov, D.S., Tarakanov, O.V. (2015), Analysis of modern attacks on antiviruses. *Journal of Theoretical and Applied Information Technology*, 76(1), 59-63.
- Skvortsova, E., Nekrasov, L. (2003), *The Organization and Planning of Engineering Production Management: Textbook*. Moscow: Higher School.
- Turovents, O., Bukhalkov, M., Rodionov, V. (2008), *The Organization of Production and Management Company: Textbook*, (Higher Education). 2nd ed. Moscow: INFRA-M. p544.
- Zakharov, A.A., Olennikov, E.A., Payusova, T.I., Silnov, D.S. (2016), Cloud service for data analysis in medical information systems using artificial neural networks. *International Journal of Applied Engineering Research*, 11(4), 2917-2920.