

# Methodological Aspects of Assessing the Innovative Potential of Machine-Building Enterprises as a Basis for Future Development

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The aim of the study is the modern concept of the innovative potential of machine-building enterprises. The attention is focused on the need for a complex approach to the innovative development of enterprises to have competitive advantages in the future. The methodology and methods of complex assessment of innovative potential is set up by the use of real quantitative indicators of enterprises and the point method of complex expert assessment with the account of development criteria. The calculated innovative potential of the enterprise shows the simplicity of the used method and effectiveness of the results.

**Key words:** *Effectiveness of using the innovative potential of the enterprise, Indicators used to assess innovative potential, Innovative activity, Innovative potential of the enterprise, Types of innovations.*

## Introduction

Nowadays the strategic development of enterprises and whole industries has to be based on the opportunity to update all spheres of activity due to time (Popov, Sekisov & Shipilova, 2016).

The widespread innovations in manufacturing industry, to a large extent, determines its commercial success and competitive advantages in both the domestic market and in the world (Shatrakov, 2013).

The course on the innovative development of the economy transforms the achievements of scientific and technological progress towards the real emergence of new goods, technologies, equipment, materials, etc. (Archibald & Archibald, 2016). Machine-building enterprises as an

object of research are the basis for the development of the country's economy as a whole. They have (Khrustalev, 2016):

- Developed material and technical bases for production;
- Breadth of use of technological processes;
- Large assortment of products and services;
- Certain experience in introducing a wide range of innovations;
- Financial opportunities for implementing innovative processes, etc.

For these enterprises, the problem of assessing and developing innovative potential is most relevant.

Today, each enterprise has a certain experience in introducing innovations, i.e. has a certain innovative potential.

Innovative potential is still poorly understood. According to the authors, the value of innovative potential is a criterion for rating an enterprise and can also be used to determine the prospects for its development.

With the most general approach, the innovative potential of an enterprise ought to be understood as the ability to develop and implement various innovations that (Putyatina, Barsova & Orlova, 2017):

- Improve the quality of manufactured goods (structures) based on the technical and economic characteristics;
- Expand the range of products due to new types;
- Introduce of new technological processes, equipment, materials, organisational forms of labor, management, and many other areas of activity.

The innovative activity of modern machine-building enterprises has many development conditions, which are defined by:

- Interest and financial support from the state and industry;
- Financial well-being of the enterprises, which have a fairly high level of self-financing;
- Programs to stimulate scientific and technological developments in the field of engineering;
- Availability and development of intellectual property;
- Interest of external investors or enterprises in participating in the development of several leading enterprises;
- Training of young creative staff and teams capable of generating innovative ideas and putting them into practice.

The definition and analysis of the innovative potential of enterprises has great importance when they are compared for (Novikov, 2018):

1. Industry (in the distribution of government orders);
2. Investors (with alternative use of invested funds);
3. Partners entering into joint innovative projects, etc.

### **Methodology**

While opening up more deeply the complex concept of the “innovative potential of enterprise” it is more logical to look through the different elements characterising its potential today (Putyatina, Barsova & Orlova, 2017; Novikov & Gavrilova, 2019), which include:

1. Company's capabilities (realised and unrealised) in a particular field of activity in accordance with its specialisation.
2. Amount of resources and reserves of the enterprise both involved and not involved in production.
3. Ability of the team to efficiently use resources and reserves in order to improve the efficiency of the enterprise.
4. Organisational structure of the enterprise and the effectiveness of the selected forms of management in general and at the level of individual areas of activity, and its innovative development.
5. Innovative capabilities of the enterprise, determined by the regular implementation of various innovations in their activities, as well as the use of effective organisational forms of management, etc.
6. Financial capabilities of the enterprise for the implementation of innovative processes, etc.

The considered areas in the real practice of enterprises are provided by the (Popov, Sekisov & Shipilova, 2016; Arsenieva, Putyatina, Barsova & Golov, 2019):

- Amount and quality of available resources (total number of employees and workers, their qualifications, level of technical equipment of production processes, composition and quality of the materials used, means of mechanisation and automation of production and management, modern means of accounting, etc.);
- Ability of employees to develop and implement a wide range of innovations, which are educational, qualifying, psychological and motivational, as well as informational abilities, i.e. the ability to receive the necessary information, process it and use it when making innovative management decisions in real practice;
- Management effectiveness in order to make the best use of available resources and others.



In total, the considered components form the whole ability of the enterprise forms its innovative potential.

The innovation potential saved by the enterprise can be used effectively with high feedback and can be used badly with low feedback. Sometimes enterprises with small innovation potential (resources) use it quite well and have high resulting indicators of their activity. But sometimes they have high innovative potential in all their constituting elements and at the same time have low effectiveness of their activity for objective and subjective reasons (Arsenyeva & Pavlova, 2017; Novikov, 2018).

The practice shows that innovative potential itself is not yet an indicator of the high performance of the enterprise.

For assessment of the innovative potential of the enterprise, it is necessary to develop appropriate methods to determine not only the potential itself but the effectiveness of its use and development.

Methodologically complex assessments of the innovative potential of a machine-building enterprise is more logical to conduct following the point method of expert assessment, taking into account the developed criteria (Table 1).

**Table 1:** Distribution of indicators and innovative potential of the enterprise by criteria levels

№	Indicator	Legend	Unit	Grade level		
				High	Medium	Low
1	The annual number of new introduced products	$n_{new}$	pieces	$> 5$	$2 \div 5$	$< 2$
2	The share of new goods in the total amount of trade production	$S_{new}$	%	$> 20$	$10 \div 20$	$< 10$
3	The share of new introduced advanced technologies in the total complexity of production	$S_{tech}^{new}$	%	$> 20$	$10 \div 20$	$< 10$
4	The share of new equipment and tools that are introduced	$S_t^{new}$	%.	$> 15$	$5 \div 15$	$< 5$
5	The share of new construction materials	$S_{mat}^{new}$	%	$> 10$	$5 \div 10$	$< 5$
6	The level of mechanisation and automatisisation of main and supporting works	$L_{mech}$	%	$> 30$	$10 \div 30$	$< 10$
7	The average annual coefficient of reduction of labour intensity of manufactured products	$C_{li}^{aa}$	%	$> 20$	$10 \div 20$	$< 10$
8	The level of computerisation of planning and accounting work	$L_{comp}$	%	$> 70$	$50 \div 70$	$< 50$
	Score rating of the indicator	SR	-	15	10	5
	The total score of the innovative potential of the enterprise by levels	$SR_{\Sigma}$	-	$> 90$	$70 \div 90$	$< 70$

A complex analysis of the innovative potential of the enterprise in general case is advisable to carry out the following methodology:

1. Determining the goals and objectives of assessing the innovative potential of an enterprise, for example:
  - To look after the dynamics of changes in the indicators of the innovative potential of the enterprise to determine the dynamics of its development for the considered period of time and summarise the results for a complex assessment;
  - To conduct a comparative assessment of the innovative potential of the enterprise with the main competitor or with a certain number of industry leaders;
  - To conduct a comparative assessment of the performance of the enterprise with industry average achievements in this industry.
  - There is one methodological feature. When comparing enterprises, those used are related by some criterion, for example, the number of employees, the value of assets, etc.
2. The most important indicators, which are determined in order to assess the innovative potential of the enterprises under consideration, take into account their specifics, in order to conduct a complex analysis on an expert basis.
3. Calculation of the selected indicators for the investigated company.

4. In a first approximation, it is suggested to evaluate the innovative potential of the enterprise by levels (high, medium, low).
5. When quantifying the innovative potential of an enterprise, it is advisable to use the point method of expert assessment, taking into account the developed system of criteria levels (Table 1)
6. If the value of a certain indicator of an enterprise falls into an assessment corresponding to a high level, it is assigned 15 points, an average level has 10 points, and a low level has 5 points (Table 1).
7. Regarding the amount of the points scored for the enterprise as a whole, and based on the Table 1, it is assigned the level of innovative potential at the levels similar to those of the indicators (high, medium, low).

## Results

The system of indicators that define the innovative potential of enterprises has to quantitatively consider such innovations that are introduced in every explored period.

Such indicators, in the first approximation, can be:

1. The annual number of new introduced products ( $n_{\text{new}}$ ). Since the development and implementation of new products can be carried out quite irregularly depending on various objective and subjective factors, it is advisable for a multiproduct machine-building enterprise to determine this indicator by introduced goods ( $n_{\text{new}}$ ), the degree to which production has been mastered and introduced in the considered period of time ( $n^*_{\text{new}}$ ), and the productions under development.

Since new products may differ among themselves in the complexity of production, and the duration of revenue, it is also advisable to consider the following indicators.

2. The share of new goods in the total amount of trade production ( $S_{\text{new}}$ ) in the current period, which is calculated by the following formula:

$$S_{\text{new}} = \frac{Q_{\text{cp}}^{\text{new}}}{Q_{\text{cp}}} \times 100\%, \text{ where}$$

$Q_{\text{cp}}^{\text{new}}$  is the amount of new marketable products produced in the current year (million rubles);

$Q_{\text{cp}}$  is the total amount of marketable products produced in the current year (million rubles).

The greater the share of new products and their modifications annually mastered by the enterprise, the higher its innovative potential.

3. The share of new introduced advanced technologies in the total complexity of production ( $S_{\text{tech}}^{\text{new}}$ ) can be determined as follows:

$$S_{\text{tech}}^{\text{new}} = \frac{C_{\text{whole}}^{\text{new}}}{C_{\text{whole}}} \times 100\%, \text{ where}$$

$C_{\text{whole}}^{\text{new}}$  is the total complexity of the products, in the production of which new technologies were used in the current year (man-hour);

$C_{\text{whole}}$  is total labor input of the products for the year (man-hour).

An increase in the share of advanced technologies that were introduced in the total labour intensity of production increases innovative potential when considering production and the enterprise as a whole.

4. The share of new equipment and tools that are introduced ( $S_t^{\text{new}}$ ) in the total cost of all equipment is determined by the following formula:

$$S_t^{\text{new}} = \frac{C_t^{\text{new}}}{C_t} \times 100\%, \text{ where}$$

$C_t^{\text{new}}$  is the cost of new equipment used by production in the current year (thousand rubles);

$C_t$  is the total cost of all equipment used in production in the current year (thousand rubles).

Increasing the introduced equipment to manufacturing raises the level of its technical equipment and, accordingly, the innovative potential of the considered enterprise.

5. The share of new construction materials used in the manufacture of products ( $S_{\text{mat}}^{\text{new}}$ ) in the total cost of the materials used is determined by the following formula:

$$S_{\text{mat}}^{\text{new}} = \frac{CP_{\text{mat}}^{\text{new}}}{CP_{\text{mat}}^{\text{whole}}} \times 100\%, \text{ where}$$

$CP_{\text{mat}}^{\text{new}}$  is the cost of new materials used in the production of products this year according to the estimated costs of production (thousand rubles);

$CP_{\text{mat}}^{\text{whole}}$  is the total cost of materials used in production in the current year (thousand rubles).

Increasing the share of new constructive materials in manufacturing raises quality and reliability of made products.

6. The level of mechanisation and automatisisation of main and supporting works ( $L_{\text{mech}}$ ) determines the ability of the enterprise to reduce the complexity of production and the duration of its production cycle due to preparatory and auxiliary operations and the movement of products during their production. It is determined by the following formula:

$$L_{\text{mech}} = \frac{C_{\Sigma}^{\text{aux mech}}}{C_{\Sigma}^{\text{aux}}} \times 100\%, \text{ where}$$

$C_{\Sigma}^{\text{aux mech}}$ ,  $C_{\Sigma}^{\text{aux}}$  is the total complexity of the auxiliary work, determined on the production program of the enterprise, respectively, performed by a mechanised method and the total one (hour, norm-hour).

The higher the level of mechanisation and automatisisation of main and supporting works, the higher the organisational and technological potential, which decreases the labour input of production of goods, the duration of its production cycle and self-cost.

7. The average annual coefficient of reduction of labour intensity of manufactured products ( $C_{li}^{aa}$ ) characterises the innovative and technological capabilities to improve the production of various products and, accordingly, reduce its complexity and cost.

This is a very important indicator for the production of machine-building enterprises because there are goods in different periods of time that have reserves for reducing the complexity of their production in the usage of new technologies, materials, etc., and goods that are made for a long period of time whose complexity cannot be reduced in the future. That is why it is advisable to determine the average rate of decrease in the complexity of the studied time period in comparison to the previous one over the whole range of products by the following formula:

$$C_{li}^{aa} = 1 - \frac{\sum_{i=1}^R Li_i^{pl} \times V_i^{pl}}{\sum_{i=1}^R Li_i^b \times V_i^{pl}} \times 100\%, \text{ where}$$

$Li_i^{pl}$ ,  $Li_i^b$  is the complexity of the production of the i-th product, respectively, in the planned and base periods (hour, norm-hour);

$V_i^{pl}$  is the amount of production of the i-th product in the considered period (pcs.);

R is the range of production.

For example, there is a meaning in the calculation:  $R_{act}^{pl} = (1 - 0,86) \cdot 100\% = 14\%$ . This means that the enterprise this year on average lowered the labor input of products by 14% due to bringing in technologies.

The higher the meaning of this indicator is, the higher the innovative potential of the enterprise.

8. The level of computerisation of planning and accounting works ( $L_{comp}$ ) is an important indicator that determines the efficiency and quality of the production information base on the enterprise. It is determined by the following formula:

$$L_{com} = \frac{n_k}{n_\Sigma} \times 100\%, \text{ where}$$

$n_k$ ,  $n_\Sigma$  is the number of works that do computerised planning and accounting work throughout the whole company.

The higher the level of computerisation of planning and accounting works is, the faster the accounting information is being looked through, and the higher the level of quality of manufacturing, the higher the innovative potential with the constant implementation of progressive program products.

In the practical activity for estimating innovative potential, other indicators can be used, which define the specifics of production concrete capacity or enterprise.

Table 2 shows the considered estimated indicators that are given for the analysis of the innovative potential of machine-building enterprises.

**Table 2:** Estimated indicators to determine the innovative potential of the enterprise

№	Indicator	Legend	Unit	Dynamics by years			Positive trend in dynamics
				year 1	year 2	year 3	
1	The annual number of new introduced products	$n_{new}$	pcs.	2	4	6	↑ +
2	The share of new goods in the total amount of trade production	$S_{new}$	%	20	30	35	↑ +
3	The share of new introduced advanced technologies in the total complexity of production	$S_{tech}^{new}$	%	10	15	25	↑ +
4	The share of new equipment and tools that are introduced	$S_t^{new}$	%.	5	25	8	↑ +
5	The share of new constructive materials	$S_{mat}^{new}$	%	6	8	10	↑ +
6	The level of mechanisation and automatisisation of main and supporting works	$L_{mech}$	%	25	30	35	↑ +
7	The average annual coefficient of reduction of labour intensity of manufactured products	$C_{li}^{aa}$	%	15	20	22	↑ +
8	The level of computerisation of planning and accounting work	$L_{comp}$	%	30	40	60	↑ +

These indicators should be considered in the dynamics through the years, for the most complete picture of their change and to obtain a definite conclusion about the change in the innovative potential of the enterprise. For comparison, it is important to have similar indicators of another enterprise to a competitor or average figures in mechanical engineering.

The same table shows the positive dynamics of indicators, which increases the innovative potential of the enterprise in the process of its development.

Now we are going to count the level of innovative potential of the considered enterprise in terms of the concrete numbers that are given in the Table 3.

**Table 3:** Estimated indicators to determine the innovative potential of the enterprise

Indicator	Year 1		Year 2		Year 3	
	In physical units	In points	In physical units	In points	In physical units	In points
$n_{new}$	2	10	4	10	6	15
$S_{new}$	20	10	30	15	35	15
$S_{tech}^{new}$	10	10	15	10	25	15
$S_t^{new}$	5	10	15	10	8	5
$S_{mat}^{new}$	6	10	8	10	10	10
$L_{mech}$	25	10	30	10	35	15
$C_{li}^{aa}$	15	10	20	10	22	15
$L_{comp}$	30	5	40	5	60	10
Total		75		80		100
Change				+ 6,7%		+25%
Level of innovative potential of enterprise	Middle level of innovative potential		Middle level of innovative potential		High level of innovative potential	

Scores that were determined on the base of real indicators of enterprise that were given in Table 3 show the following:

1. In the first year of a considered period, all indicators have a middle level of innovative activity and the innovative potential itself can be attributed to middle level.
2. In the second year, the indicators themselves grew, but they stayed within the middle level, as well as the innovative potential itself. However, we should notice that in a complex assessment of innovative potential there was an increase of 6.7%.

3. In the third year, all indicators grew and were attributed to a high level. In this case, 5 out of 8 indicators reached a high level in terms of their values, and received 15 points in accordance with the criteria table.
4. In a complex assessment, the growth of innovative potential at the end of the period was 25%, compared to the previous year and was attributed to a high level.

In this case, the innovative activity of the enterprise for the considered period can be stated.

## **Discussion**

The modern direction of the research about the potential theory of enterprises has been developing since the 1990s. Many authors develop methodical materials according to the assessment of various types of potentials: economical, labour, technical, etc. In scientific publications, there is a discussion of what type of enterprise most closely reflects the current need of interested users for this information (Gassmann, Frankenberger & Sauer, 2016; Mottaeva, Zheltenkov, Stukanova, Ryabichenko & Zhuk, 2016). It is impossible to come to a consensus in this case since each interested user has their own system of priorities: for investors and industry structures this is an innovative activity that comes through in the successful realisation of scientific and technological projects; for shareholders, this is a stable development of enterprise and profitability in its activity.

If the concept of economic potential is mainly connected with the amount and quality of used enterprise resources, then the labour potential is concentrated on the creative component, which, to a large extent, determines technical progress in the industry regarding the challenges of providing economic growth and updating both the goods and technologies that were used in the process of production.

The complexity and controversy of assessing the innovative potential of an enterprise lies in the conceptual approach and composition of indicators. It is quite difficult to quantify the innovative capabilities of an enterprise quantitatively for comparison and choice as partners for future development. Therefore, the largest number of studies in this direction use expert methods based on the individual approach of each specialist to the problem under consideration. However, as it is known, a set of subjective opinions with a sufficient sample leads to an increase in the objectivity of the conclusions.

The ability of enterprises in innovative development and the level of competitiveness in foreign practice are often used for assessing the following:

- Indicator method, that covers a massive number of different indicators from the scientific maturity of designers and technologists to the level of financing research areas by the enterprise;



- Matrix method, in which the dynamics of market capacity with the dynamics of the market share that are taken by the enterprise are compared (Afuah, 2014).

Following these methods, there is the determined level of ownership of enterprises on the world market, domestic market, industry market, etc.

However, both methods do not take into account the innovative component of enterprise development.

Despite the many discussion points, each study has a certain degree of objectivity and facilitates a scientific direction, by such means as the theory of enterprise potentials.

## **Conclusion**

Innovative development in the economy of any state needs science and technical progress in the form of new goods, technologies, equipment, materials, etc. Any innovations in the industry provide the competitive advantages of enterprises and industries on the scale of global competition.

Nowadays, each enterprise has a certain experience in introducing innovations, i.e. it has a certain innovative potential, which, with the most general approach, should be understood as the ability to develop and implement various innovations that provide it with technical and economic superiority.

Machine-building enterprises as an object of research are the main indicator of development for a country's economy as a whole. They have:

- Developed material and technical bases for production;
- Breadth of using technological processes;
- Large choice of products and services;
- Financial opportunities, etc.

Indicators that determine innovative potential are the following:

- Annual amount of new introduced goods;
- Share of new goods in the total amount of commodity production at the enterprise;
- Share of new introduced advanced technologies in the total complexity of annual production;
- Share of new equipment introduced into production, etc.



A methodologically complex assessment of the innovative potential of a machine-building enterprise is suggested to be made following the point method of an expert assessment, which takes into consideration the developed levels as criterion for providing simplicity in calculations and the increased effectiveness of the results.

The suggested methodological developments increase and decrease the number of used indicators and upgrade the criterion levels of their assessment according to the level of development of the industry and manufacturing.

Through calculations and analysis of changes in the innovative potential of enterprises, it is possible:

- To trace the level of innovative development of enterprises in the industry;
- To identify leaders of innovative development based on their activity;
- To participate in tenders for the execution of especially important state orders;
- To reasonably make a decision on cooperation in the framework of the implementation of large innovative projects at the intersectoral level.

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