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INNOVATIVE DEVELOPMENT OF MECHANICAL ENGINEERING IN UKRAINE: EVALUATION AND ANALYSIS

In the article the methodical approaches to the evaluation of innovative development of machine-building at the national level were considered. The modern methodological toolkit to the assessment of the innovative development of industrial branches was analyzed and systemic, structural, quantitative-qualitative, dynamic and situational approaches were defined. It was outlined the main problems which arise in assessing the innovative development of mechanical engineering. It was determined that the innovative development of engineering can be estimated in four directions: production of computers, electronic and optical products; manufacture of electrical equipment; manufacture of machinery and equipment; the production of vehicles. Reasonably, this approach allows us to evaluate the level of innovative development of engineering, comparing with existing approaches, and identify opportunities for their development more accurately. The algorithm of calculation of the integral index of innovative engineering, which has a hierarchical system where level 1 is generalized integral index, level II is for group integral indexes; level III is for indicators that characterize some aspects of group integrated indexes. On the basis of the proposed method cumulative index of innovative development of mechanical engineering in the national economy was offered and an assessment of its dynamics for 2013-2015 was made. The main problems of innovative development of machine-building industry were identified and priority measures of the State industrial policy on a particular level were proposed, i.e. criteria of the priority selection and their content were defined.

Keywords: innovative development, branch, mechanical engineering, methodical approach, index, evaluation, analysis, industrial policy, priority.

Formulation of the problem. Mechanical engineering is one of the most important sectors of the national industry, because the level of its development influences the status of all other industrial sections and innovative vector of the country in a whole. Machine-building industry is the core of the secondary sector of economy, which determines the level of efficiency, automation and the capacity of resources of the national production. Currently more and more machine-building enterprises of Ukraine are aware of the important role of innovation in improving of their economic efficiency, enhancing of competitive advantages, expanding the sphere of business and prospects for the development of new markets. Therefore, an urgent task is to identify the level of innovative development of machine-building industry of Ukraine.

Analysis of recent scientific research. The research of innovative development of the engineering and development of methods to ensure its evaluations was done by such scientists as O.S. Oliinyk, Ye.H. Riasnykh[1], T.I.Tovt[2], T.M. Piliavoz [3], D.Iu.Kramskoi, O. I. Kolotiuk [4] and others. The study and generalization of the experience of the scientists made it possible to determine that issue comprehensive

[1] Олійник, О.С., Рясних, Є.Г. (2014). Формування методичних підходів до визначення факторів інноваційного розвитку машинобудівних підприємств. *Вісник Хмельницького національного університету, 5(2), 249.*
[2] Товт, Т.Й. (2011). Методичні підходи до обґрунтування системи показників оцінювання інвестиційного забезпечення інноваційної діяльності машинобудівних підприємств. *Науковий вісник НЛТУ України, 21.5, 288.*
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[4] Крамською, Д.Ю., Колотюк, О.І. (2013). Аналіз інструментарію дослідження інноваційного розвитку підприємства. *Бізнес Інформ, 5,* 255.

assessment requires further research and theoretical studies, because not enough studied remain questions of innovative development of machine-building at the national level in terms of industries.

The purpose of the article. The aim of the research is to assess the level of innovative development of Ukrainian machine building industry on the basis of integral-index techniques and discover its features in terms of sub-sectors to the formation of the directions of the State industrial policy of innovative development.

Explanation of the basic material of the study. In the Study of scientific works of M.Voinarenko[1] and M.Chorna [2] a range of different methods and algorithms of estimation of system of indicators of the development of various industries or certain types of activities was revealed. The systematization of these approaches allows you to detect and point that scientists often use a systematic, structural, quantitative-qualitative, dynamic and situational approaches for the estimation of the development of a branch, the essence of which is represented in Table 1.

In order to make the more comprehensive evaluation of the innovative development of mechanical engineering it is advisable to combine these approaches. The performance of two tasks is one of perspectives of our further research:

1) the determination of the types of activities of the engineering, so-called poles of innovation;

2) the separation of the directions of the innovative activity in machine-building coordination in the context of changing the structure of the industry, the areas of exports and development of innovation activity.

Based on mentioned above we believe that the evaluation of innovative development of the industry must be fulfilled by taking into account the combination of structural, index and situational approaches. For this purpose the four directions of structural analysis must be chosen: 1 – manufacture of computers, electronic and optical products; 2 – production of electrical equipment; 3 – manufacture of machinery and equipment, which are not enlisted to other groups; 4 – the production of motor vehicles, trailers and semi-trailers and other vehicles.

Table 1

Classification of approaches to the analysis of the development of the industry

Name of the Approach	Characteristic
Systematic approach	The Object of the Study is represented as a system of interrelated elements. It actively interacts with the environment. The indicators, which characterize the separate elements and the system in complex, were chosen for the Study.
Structural approach	Object of the Research is the structure of the industry. The indicators were represented in the form of a hierarchy, which has different level. The first level is represented by single indicators. They are grouped in the complex ones at the second level and at the third level they unite in General ones.
Quantitative-qualitative approach.	The object of Study is the functioning of the industry via the lens of quantitative and qualitative criteria. Qualitative characteristics of the development are represented by using the methods of expert assessments, economic-mathematical modeling and statistics, and quantitative ones are interpreted through economic indicators of results and efficiency.
Dynamic approach	Object of the Research is the dynamic development of the industry. The indicators create dynamic sets and their change during a certain period can be analyzed.
Situational approach	The Object of Study is the status, scope and perspectives of the industry. Indicators of the development are selected depending on the goals and tasks of assessment and prospects of the industry.

Source: It is compiled by the author.

Based on the mentioned above we believe that the evaluation of innovative development of the industry it is more reasonable to take into account the combination of structural, index and situational

[1] Войнаренко, М.П., Зінченко, С.Г., Злепко, С.М., Тарута, О.О. (2011). *Інноваційні стратегії управління підприємством за умов глобалізації*. Хмельницький: ХНУ.

[2] Чорна, М.В., Глухова, С.В. (2012). *Оцінка ефективності інноваційної діяльності підприємств*. Харків : ХДУХТ.

approaches. Four directions of structural analysis were determined for this purpose: 1. manufacture of computers, electronic and optical products; 2. production of electrical equipment; 3. manufacture of machinery and equipment are not in-listed to other groups; 4. the production of motor vehicles, trailers and semi-trailers and other vehicles.

A challenge is to define a scorecard that will allow conducting a comprehensive analysis of the innovation of engineering according to these four ways in the future. A system of 15 indicators, which characterize the State of the industry on the basis of such criteria as the entrepreneurial activity, the focus of innovative activity, financial activity, introduction of innovative processes, market innovative enterprise "leap" , export orientation of innovation (table 2), was developed for the evaluation of innovative development of machine-building industry in national economy.

Table 2

Indicator system for the evaluation of the innovative development in engineering

The name of the criterion	The Characteristic of Indicators
entrepreneurial activity	– the ratio of quantity of industrial enterprises, which engaged into innovative activity, to the total number of machine-building enterprises
focus of innovative activity	– the ratio of expenditures on domestic research to total costs of innovative activity; – the ratio of expenditure on external research to the total costs of innovative activity; – the ratio of expenses on the purchase of machinery, equipment and software to the total costs of innovative activity; – the ratio of the cost and other external knowledge to the total costs of innovation activity; – the ratio of expenditure on external research to the total costs of innovative activity;
financial activity	– the ratio of own costs to the total volume of financing innovative activities; – the ratio of expenditures from the State budget, local budgets and non- budgetary Fund to the total volume of financing innovative activities; – the ratio of the cost of domestic, foreign investors, loans and expenses from other sources, to the total volume of financing innovative activities.
introduction of innovative processes	– the ratio of the number of industrial enterprises that introduced low-waste and resource saving processes to the total number of enterprises that introduced innovative processes; – the ratio of the number of industrial enterprises that introduced innovative products to the total number of enterprises that introduced innovative processes; – the ratio of the number of industrial enterprises, which implemented the innovative types of products, that are new on the market to the total number of enterprises that introduced innovative processes.
market innovative enterprise "leap"	– the ratio of the volume of sales of innovative products, which was new on the market to a number of industrial enterprises, that have implemented it; thds. hr/unit. – the ratio of the volume of sales of innovative products, that was new only for the enterprises of the industrial enterprises that have implemented it; ths. hr/unit.
export orientation of innovation	– the ratio of the volume of sales of innovative products, realized abroad to a number of industrial enterprises, that have implemented it, ths. hr/unit.

Source: It is compiled by the author.

Comprehensive evaluation of innovative development of machine-building industry into the national economy requires the aggregate use of these indicators. More revealing index method is selected for its realization.

We offer to apply hierarchical system l to assess the development: level 1 is generalized as integral index of innovation engineering, level II is for Group integral indexes (the index of computer, electronic and optical products, index of electrical equipment, the index of machinery and equipment, are not known to other groups, the index of vehicles); level III is for indicators that characterize some aspects of group integrated indexes. The calculation of the integral index of innovation in Engineering II_E, which is performed by the formula of average geometric group indexes (the index of computer, electronic and optical products I_{CE}, index of electrical equipment I_{EE}, the index of machinery and equipment I_{ME}, are not known to other groups, index of vehicles I_V) becomes successful in the selected approach. The algorithm of calculation of integral of the indicator is to perform the three steps that are presented in Fig. 1.

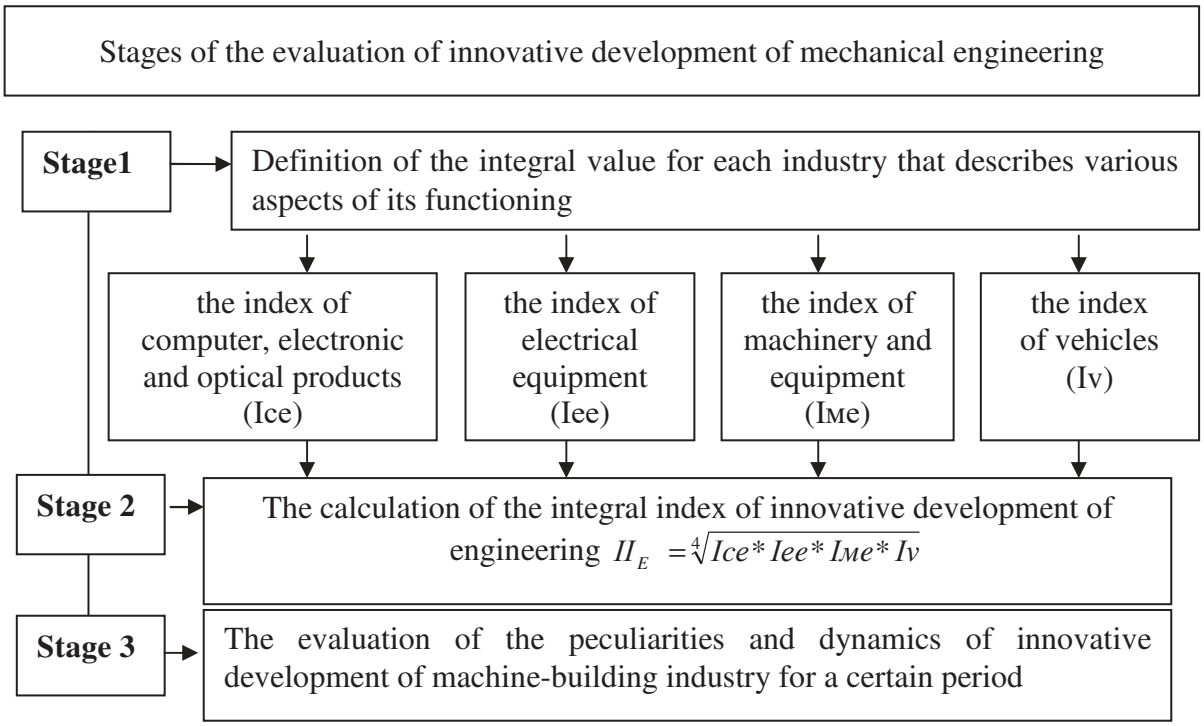

Fig. 1. An algorithm of the estimation of innovative development of machine-building industry (compiled by the author)

On the basis of the proposed methods cumulative index of the innovative development of mechanical engineering in the national economy was defined and an assessment of its dynamics in 2013-2015 was made (Fig. 2.).

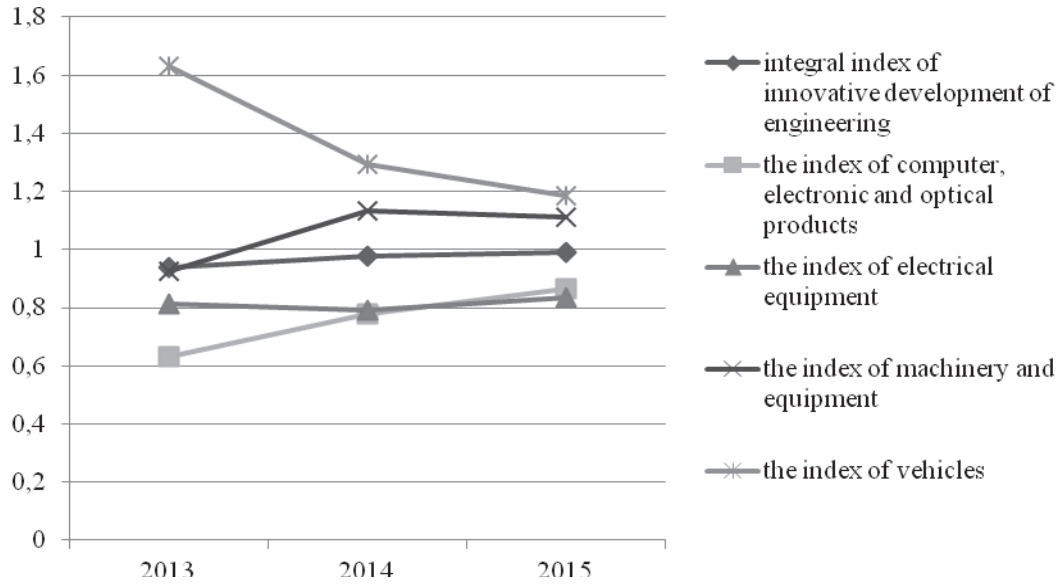

Fig. 2. The dynamics of the integral index of innovative development of engineering and its components in 2013-2015

Source: calculated by the author on the basis of[1]

[1] *Офіційний сайт Державної служби статистики України*. Наукова та інноваційна діяльність . <http://www.ukrstat.gov.ua/>

It was determined that in 2015 the highest level of innovative development belonged to small industrial sector of production of motor vehicles, trailers and semi-trailers and other vehicles (1.186), and the lowest level was for electrical equipment (0.835). It is defined that II_E Ukraine is characterized by growing Dynamics (II_E increased by 5.3% in 2015, compared to 2013); the index of computer, electronic and optical products is characterized by positive dynamics (36.8%); index of electrical equipment and the index of machinery and equipment by mixed dynamics, index of vehicles, trailers and semi-trailers and other vehicles is negative one (contraction of 27.15%).It is possible to state that the value of the innovative development of the individual branches of engineering in Ukraine is not to be properly estimated, and the problem of stabilization of its development is still escalating.

Application of index method for the calculation of the index of innovative development of mechanical engineering in the national economy gave the possibility to detect the worsening problems of activation of entrepreneurial innovative activity of machine-building enterprises, one-directional costs of innovative activity for the purchase of machinery, equipment and software, lack of funding from the State budget and by foreign investors, banking institutions, implementation of low-waste and resource-saving innovative processes slowing the implementation of new innovative products on the market.

In view of the above mentioned trend of innovative development of engineering requires a specific role of the State in the form of industrial policy.

The goal of industrial policy in the field of engineering is to achieve the innovative development of mechanical engineering which saturates the production by new technical means and technologies and which is the main source of innovative and economic growth of the country, improving the efficiency and productivity of the social labor and welfare of the population[1]. This objective is achieved with the introduction of the concept of industrial policy, which provides for the state to become a regulator of industrial policy development and active support of those sectors that are strategically important for the Ukrainian economy[2].

But the important task is to define precisely the definition of these priorities in the development of engineering, which will help to restore its role as the locomotive of economic growth in Ukraine and promote the modernization of the economy of the State in a whole.

It is common knowledge that the choice of prior directions of development of individual industries, types of production, territories (as elements of an active structural policy) is in defining the sectors (manufacturing, territorial economic systems with strong feedbacks) that can cause a relevant reaction of development, cause positive changes in the economy and ensure the implementation of the goals of State economic policy.

Priority industries are believed to be the industries, which the State prefers to posses among the leaders, considering their role and importance for the economy of the country.

The formation of the priorities, probably "top"-from the State and the "bottom" from business are possible. Practice shows that the formation of the "bottom» priorities is more efficient for specific areas. The higher the degree of sectoral priorities, the easier to propose instruments for their implementation and to evaluate the effects. Partially industrial policy can be directed not only to the solution of the problems of branch, but even a single firm. However, the scale of industrial policy is generally based on the "opposite" direction, dialogue between business and Government. However, the scale of industrial policy is generally based on the "opposite" direction, dialogue between business and Government.

It should be noted that in the European Union understanding of the appropriateness of the "soft" industrial policy as for the priority of high-tech industries, which is based on the cooperation of the Government with industry in order to improve the performance of industrial enterprises through the Elimination of barriers (infrastructure, financial, trade, regulatory, information, personnel, technological, etc.) was formed. According to such policy the role of the Government is more stimulating and coordinative[3].

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[2] Свєженцев, О.О. (2016). Перспективи розвитку машинобудівної галузі України: формування нової концепції промислової політики. *Управління розвитком, 2 (184), 14.*

[3] Центр економічної стратегії. *Чи потрібна Україні промислова політика?* <http://ces.org.ua/wp-content/uploads/2015/07/ces_ industrial_policy_20150810_ukr.pdf>

Speaking of industrial policy at the specifically-operational level, it is necessary to determine not only its content, but also the criteria for selection of priorities. In any case, the original premise of any industrial policy is the choice of priorities or "growth poles" and "corridors" growth for the formation of long-term policy focused on achieving the sustainable development on the basis of ensuring the economic security of the country.

Taking into account the results of the evaluation and analysis of integral index of the innovative development of machine building of Ukraine priority measures of the State industrial policy based on cooperation with representatives of industry and institutional units (banks, export-import organizations, scientific and educational institutions and research institutes) (Table 3) are offered.

Table 3

The priority measures of the State industrial policy of the innovative development of engineering in terms of industries

The name of the criterion	Production			
	computers, electronic and optical products	**electrical equipment**	**machinery and equipment**	**vehicles**
entrepreneurial activity	coordination of entrepreneurial activity	stimulation of entrepreneurial activity	stimulation of entrepreneurial activity	coordination of entrepreneurial activity
focus of innovative activity	the development of mechanisms to promote the increasing expenditures on external research and external knowledge	the development of mechanisms for increasing costs for the purchase of machinery, equipment	development of mechanisms of coordination costs for the purchase of external knowledge	the development of mechanisms to reduce dependence on external costs of the research
financial activity	promotion of sustainability and revitalization of industry sources, reduction of dependence on public funding	formation mechanisms of public-private partnerships, promotion of the activation of internal and external investment	stimulation of investment activity of foreign and domestic investors	formation of mechanisms of public-private partnerships, promote the activation of internal and external investment
introduction of innovative processes	promotion of the introduction of low-waste and resource-saving processes	stimulation of the elaboration of innovative products	assistance to introduction of innovative processes	promotion of the development of innovative new products for the market
market innovative enterprise “leap”	the intensification of the marketing activities in the field of the implementation of new types of innovative products on the market	incentives and markets researches of new product realizations for enterprises	incentives and markets products new realizations	the intensification of the marketing activities in the field of the implementation of new types of innovative products on the market
export orientation of innovation	support of insurance and lending of export	promotion of the revitalization of export activities and search for external markets	creation of the conditions for a stable export activities	promotion the revitalization of export activities and search for external markets

Source: compiled by author

Thus, a complex and long process of the innovative development of engineering causes not only self-activation of industry, but also a new State industrial policy, system and successive actions which depends on the modernization "leap" in Ukraine and the development of high-tech engineering as the core of the new structure of the national economy.

Conclusions. The result of the conducted research is to develop a methodological approach to the evaluation of the innovative development of engineering by the algorithm of calculation of integral index, which provides an opportunity to assess the current state of the industry, to plan and forecast the development, to develop scientifically grounded measures on realization of the State industrial policy.

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