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#### РАЗРАБОТКА МЕТОДОЛОГИЧЕСКОЙ КОНЦЕПЦИИ РЕСУРСОСБЕРЕГАЮЩЕГО РАЗВИТИЯ АПК

Разработана методологическая концепция ресурсосберегающего развития АПК при помощи разработки новой модели формирования ресурсосберегающего механизма и системы основных методологических принципов формирования ресурсосберегающего механизма. На основе этой концепции в дальнейшем будет создан подход к определению тенденций и факторов развития процесса экономического регулирования через использование качественных и количественных показателей. Этот подход, в отличие от существующих, создает информационную основу для принятия обоснованных управленческих решений по выбору системы ресурсопользования.

**Ключевые слова:** методологическая концепция ресурсосбережения, ресурсоиспользование в АПК, ресурсосберегающий механизм, предприятия АПК.

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UDC 338.012

DOI: 10.15587/2312-8372.2017.109114

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## ANALYSIS OF THE UKRAINIAN INSTRUMENT-MAKING INDUSTRY INTERNATIONAL COMPETITIVENESS USING PORTER'S DIAMOND

*Проведено аналіз міжнародної конкурентоспроможності приладобудування України за допомогою ромбу національних переваг М. Портера. Аналіз проводився за такими показниками, як: факторні умови (людські ресурси, природні ресурси, фінанси, технології, інфраструктура), кластер підтримуючих галузей, попит на внутрішньому ринку та конкуренція на внутрішньому ринку.*

**Ключові слова:** приладобудування України, застосування ромбу Портера, міжнародна конкурентоспроможність приладобудування.

### 1. Introduction

Competitiveness is a key indicator that answers the questions of opportunities in achieving and maintaining certain competitive positions in the international and global markets. The instrument-making industry is one

of the most promising in the economy of our state, since it includes a complex process of production from the use of raw materials to high-precision production, thereby increasing the competitive positions of the country as a whole. That is why in this paper the competitiveness of the instrument-making industry has been studied.

## 2. The object of research and its technological audit

The object of research is the process of increasing the international competitiveness of instrument-making enterprises. To formulate recommendations on the above-mentioned facility, it is necessary to study the features and analyze the competitiveness of the industry.

In order to study the competitiveness of instrument-making enterprises, it is proposed to use the M. Porter's diamond of national advantages. It includes factor conditions (human resources, natural resources, finance, technology and infrastructure), a cluster of supporting industries, demand in the domestic market and competition in the domestic market, as well as contingencies and government influence. This method allows to comprehensively analyze the features, bring strengths and weaknesses of a certain area in order to give the opportunity to formulate a series of recommendations.

Porter's diamond is used to provide the characteristics of competitive advantages at national, sectoral levels and for individual enterprises (institutions, organizations), and in particular: for analyzing the competitive advantages of Romania [1], trade in Ireland [2], for small and medium-sized businesses in India [3] and for direct investment in retail trade [4], as well as at the enterprise level [5].

## 3. The aim and objectives of research

The aim of research is analysis of the competitiveness of enterprises.

In accordance with this aim in the work is identified and solved the following tasks:

1. To characterize the current state of the instrument-making.

2. To analyze the determinants of competitiveness by the Porter's method: factor conditions (human resources, natural resources, financial resources, technology, infrastructure), a cluster of supporting industries, demand and competition in the domestic market.

## 4. Research of existing solutions of the problem

Problems of instrument-making development and determination of competitive positions of this branch were studied by Ukrainian and foreign scientists. In the works the analysis of the state, problems and prospects of the development of the instrument-making industry in Ukraine was made, a number of factors that hinder the development of the industry are cited [6, 7]. Also, changes were made in the industry with the transition to a market economy and the general problems of the industry by analyzing changes in the state of the industry for the selected period [8]. A retrospective analysis of the industry development was also presented in the works for further research of prospects for economic growth [9]. In addition, the main trends in development of the instrument-making

industry were investigated using the example of the market for instrumentation and measuring instruments, and the capacity of the market and its individual segments was calculated. Also, the main problems and risks of the activity of enterprises producing devices and determining key factors in the development of the market for instrumentation were studied [10]. As a result of the analysis of industry trends, an integrated approach to managing the sustainable development of machine-building enterprises was proposed [11]. As part of the problem of increasing the competitiveness of enterprises of high technology engineering (instrumentation), a factor analysis of related sectors of the national economy was proposed [12]. In the above-mentioned papers, the problem of development of the industry as a component of machine-building, as well as from the point of view of direct instrument-making, was considered. The above works do not use the method of determining national advantages proposed by M. Porter and require an updated industry dynamics and are proposed in the framework of this study.

## 5. Methods or research

To solve the tasks, the following methods are used: analysis and synthesis, logical generalization, analogies and graphoanalytical methods, as well as a method of analyzing competitive advantages by M. Porter's method.

## 6. Research results

Instrument-making is a high-tech industry, part of the machine-building complex. Specialization of the industry is the production of measuring tools, automatic and automated control systems, as well as control devices [6].

According to the State Statistics Service of Ukraine, the volume of imports is 4 times higher than the volume of exports (imports are 580.195 million USD, and exports are respectively 145.689 million USD) [1]. This ratio testifies to the import-oriented nature of the instrument-making industry in Ukraine (the solvent demand of the population is not adequately met by domestic production) [13].

According to Fig. 1, the dynamics of imports is wavy: it acquires the maximum value in 2008 (1222.607 million USD), which correlates with the general economic recovery this year), and the minimum in 2015 (463.826 million USD), which can be explained by the unstable economic and political situation in the country and armed conflicts.

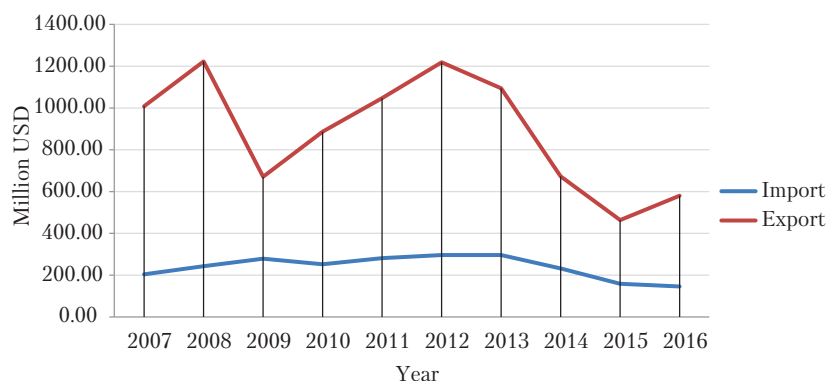


Fig. 1. Dynamics of export and import of instrument-making in Ukraine during 2007–2016, million USD (schematized by the author on the basis of [14])

The export dynamics is more stable: the peak reaches in 2012 (296.459 million USD), and the minimum in 2016 (145.689 million USD) [13].

The major exporters for Ukraine within the above-mentioned industry are the CIS countries (93924 million USD by 2016), and the major importers are European countries (567418 million USD by 2016).

It is advisable to analyze the competitiveness of the industry using the Porter's diamond of the national advantages, which allows to separately analyze the components that affect the competitiveness of the industry.

**6.1. The factor conditions.** Factor conditions can be divided into the following subgroups according to M. Porter's classification: human resources, natural resources, financial resources, technology and infrastructure.

**6.1.1. Human resources.** Since instrument making is a science-intensive sphere of economic activity, the most important factor in the field of instrumentation is the availability of highly skilled labor. Special demand is used by specialists who can find optimal high-tech solutions and inventive abilities.

To ensure the effective functioning of the industry in Ukraine there are 79 higher educational institutions that have such direction of preparation as «Automation and Instrumentation». The latter provides training for specialists in the following specialties: automation and computer-integrated technologies, metrology and information-measuring technology, micro- and nano-systems technology [15].

The low cost of labor, combined with sufficient skill level, provides an opportunity to involve them in the development of new innovative technologies. According to the State Statistics Service, the average salary of workers employed in industry was 5003.00–7172.00 UAH (as of January – December 2016) [16], while the average salary in Ukraine for the same period reached 4362.00–6475.00 UAH. In other related industries, the level of remuneration of labor was established at the level of 3771.00–5754.00 UAH for construction, 5088.00–6626.00 UAH for wholesale and retail trade, 5008.00–6878.00 UAH for transport sphere [16]. Accordingly, experts in this industry receive salary, 10–14 % higher than the average Ukrainian pay indicators and comparatively higher main related areas of activity. In addition, the relatively low cost is a key competitive advantage for this industry in Ukraine in comparison with the European Union and North America. For comparison: the average salary in the countries of the European Union for 2016 reached 1.508.61 EUR per month [17]. Since the cost of labor is relatively low, and the quality of performance can be achieved subject to a responsible attitude to the selection of personnel, an opportunity is created for the withdrawal of production from Europe to Ukraine using tolling raw materials.

**6.1.2. Natural resources.** The favorable geographical position of Ukraine can be attributed to the natural resources that provide the industry, since it is possible to deliver products with relatively low costs to Europe and the countries of the Middle East. Location in the geographical center of Europe makes it possible to accelerate the delivery and reduce the cost of transporting finished products.

Raw materials are an important, but not a key factor for the industry, since the main resource is a highly skilled workforce. For the manufacture of instruments, the products of the metallurgical complex are needed (including the color metals, which are composite electronic circuits),

as well as structural materials, produce light, chemical, and woodworking industries.

For Ukraine, there is a presence of such raw materials and materials that can be used for instrument-making (Table 1).

Table 1

Natural resources [16]

Year	2011	2012	2013	2014	2015	2016
Iron ores, non-agglomerated, million t	173	176	185	184	175	168
Concentrates of iron ore, impregnated, million t	66.5	67.1	70.4	68.3	66.9	62.9
Concentrates of iron ore, agglomerated, million t	64.4	64.6	67.6	60.2	55.2	56.7
Dyes and dispensers based on them, t	1465	1661	2028	2155	2350	2648
Substances that color synthetic organic, others, t	3986	4612	5206	3226	5143	5695
Paints and varnishes based on polyacrylic or vinyl polymers, dispersed or dissolved in aqueous medium (including enamels and varnishes), thousand t	64.2	70.1	73.5	66.7	60.7	74.6
Pig iron and mirror iron in ingots, blanks or forms of primary others, million t	28.9	28.5	29.1	24.8	21.9	23.6
Steel without semi-finished products, obtained by continuous casting, million t	17.6	16.6	15.1	12.7	11.2	11.2
Semi-finished products obtained by continuous casting, million t	17.8	16.9	18.1	14.7	11.9	13.2
Semi-finished products rolled and forged, million t	7.2	7.0	6.5	6.1	6.1	6.4
Rolled ferrous metals, million t	19.5	18.4	17.8	14.3	12.1	13.3
Pipes and tubes, hollow profiles, made of steel, million t	2.4	2.2	1.8	1.6	1.0	1.0
Electricity, billion kW · h	194.9	198.9	194.4	182.8	163.7	164.6

According to the Table 1, from 2011 to 2013 there is a (mainly) tendency to increase the produced raw materials and materials that reduces their cost (including due to economies of scale) and positively affects the possible volumes of production of devices as a commodity. The production of raw materials for instrument-making has decreased since 2014 as a result of exclusion from the calculation of the temporarily occupied territory of the Autonomous Republic of Crimea, Sevastopol and part of the zone of the antiterrorist operation. In addition to formal exclusion, there was a real decrease in production in the above-mentioned regions as a result of destructive terrorist actions that reduced the number of existing plants.

So, the conflict between the political situation in the country and the economic weakening prevented the development of the raw material base.

**6.1.3. Financial resources.** The state is interested in the development of this industry that is spelled out in the Law of Ukraine from September 8, 2011 No. 3715-VI «On Priority Directions of Innovation in Ukraine», which

defines instrument-making as one of the strategic directions of the country's innovation activity [18].

Accordingly, special programs for strategically important areas are being set up to finance the industry. For example, the program of the Kyiv City State Administration «Equipping engineering inputs of apartment houses of communal ownership, housing construction cooperatives and associations of co-owners of apartment buildings with heat meters along with the hardware and software part of dispatching», approved in 2014, allowed the installation of heat metering devices in residential buildings due to Kyiv budget. Similar programs have been launched in parallel in other cities of Ukraine. They simultaneously support the Ukrainian instrument-making industry (in the presence of competitive domestic products) and increase competition from strong foreign companies entering the Ukrainian market through government purchases.

In addition to the means of budgets of cities and the state budget of Ukraine are the own funds of enterprises investing in the development and promotion of their products.

In addition, it is possible to raise funds (including from abroad) from the NEFCO program, IQ-Energy, ESCO, etc.

The index of direct capital investments in 2017 reached 134.5 for the reporting period in comparison with the previous year, which proves the rapid growth of investment in the industry and its classification as a promising one.

**6.1.4. Scientific potential.** Ukraine is a state that has a significant scientific and technical personnel potential, which significantly affects its socio-economic development. According to the level of such impact – 5.1 researchers per 1000 economically active population – Ukraine is somewhat inferior to the EU countries (6.0 for the first 15 EU countries), but ahead of Slovenia (4.8), Slovakia and Hungary (4.2), as well as Poland (3.9) [19]. At the same time, the number of scientific personnel in Ukraine, in contrast to the vast majority of European countries, is decreasing. According to the data of 2016, the number of scientific workers was 98 thousand people, which is 20 % less than in 2016. The reason is immigration of highly qualified personnel from Ukraine due to unfavorable political situation and low salary level. The volume of expenditures for scientific development grew by 5 % in relation to the previous year in terms of applied scientific research and scientific and technical (experimental) developments and reached 1153 billion UAH for 2016 [16].

**6.1.5. Infrastructure.** The infrastructure of Ukraine is widely developed within large cities and regional centers and includes the following areas: financial, industrial, construction, educational, social, transport, as well as trade, services, communications, etc. Transport infrastructure is represented by a variety of types of means for the transport of goods. The banking infrastructure is also quite developed (though, to a large extent, due to foreign banks). Warehouse infrastructure in recent years has improved sufficiently (due to the quality work of logistics companies). In small towns there are problems with the accessibility of infrastructure institutions due to the lack of financial resources for its development. Since the production of devices gravitates to large cities, the above is an indirect factor in inhibiting the development of instrumentation.

That is, it can be noted that the infrastructure for production of devices in places is supported by transport, banking and transport components. Important steps will

be to establish production and attract investment, so as not to lose the available potential [20].

**6.2. Cluster of supporting industries.** A cluster of supporting industries includes construction, energy, transportation, trade and chemical industry.

Construction in Ukraine acquires uneven development due to the presence of uneven demand for housing as finished products. The construction is confined to large cities and near-city territories. The most active is the construction in Kyiv. In January – June, 2017, construction companies completed works worth 36 billion UAH, and the construction products index, compared to the first half of 2016, was 124.6 %. The growth in the volume of housing construction amounted to 16.5 %, and non-residential construction – 27.3 %. In addition, in Ukraine in 2017, Ukraine's Law No. 2020-VIII «On Amending Certain Legislative Acts of Ukraine to Improve the Conditions for Building Construction Activities», which will positively affect the conditions of construction, was signed [16].

The energy industry in Ukraine is import-dependent. The distribution of the consumption of the machine-building industry by types of fuel is the following (in thousands of tons of oil equivalent):

- electricity – 229;
- natural gas – 119;
- heat energy – 80;
- petroleum products – 36;
- coal and peat – 2;
- biofuel – 1.

Accordingly, the most important for this industry is electrical energy (49 %) and natural gas (25.5 %). So, Ukraine is dependent on the import of natural gas from the Russian Federation that weakens the cluster positions of energy (the volume of imported fuel 17 times higher than exports) [16].

Transport in Ukraine is quite developed. During the period January – June 2017, 166.881.2 million tons of cargo were transported, which is 9 % higher than in the same period in 2016. Distribution by mode of transport in the structure of cargo transportation is shown in the diagram (Fig. 2).

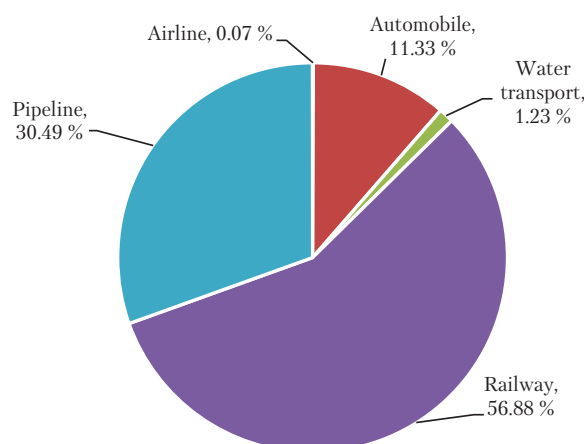


Fig. 2. Distribution of cargo transportation by mode of transport [16]

So, the most strategically important for the industry is rail transport (57 %), which allows to transfer raw materials to high-tech industries.

The chemical industry in Ukraine has its own raw materials base: chemical raw materials (sulfur, salts, phos-

phorites), waste parts from other industries, as well as oil, coal, natural gas. High-tech chemical industries are also represented in Ukraine (for example, Ecomix mixtures of Ecosoft for water purification devices), but the import dependence of the industry is observed (the volume of imports is 12.4 times higher than exports) [16].

Trade occupies a significant share of Ukraine's GDP. In fact, it performs the function of a manufacturer's connector with intermediaries, partners and end-users. The volume of products sold in the industry in 2016 reached 2249.13 billion UAH. The volume of trade in relation to GDP according to 2015 is 12.3%, which is 1% higher than in 2010, which indicates the progressive development of trade [16].

Despite the development of the sectors that are part of the supporting cluster, there are problems of import dependency and the need for investments that will allow the production of domestic products.

**6.3. Demand conditions in the domestic market.** Domestic market is characterized by the existence of an average and high level of demand among consumers for the quality of products along with low purchasing power. This trend is illustrated by the existing «Prozorro» system, created for the withdrawal from the shadow of public procurement. Electronic auctions allow to purchase products at the lowest price, but there is a possibility of loss by the criterion of product quality. This negatively affects manufacturers who produce high-quality, but more expensive products. Average prices of purchased products are reduced along with a corresponding decrease in quality, a reduction in the life cycle of goods.

According to the State Statistics Service, for January – June, 2017, machine-building products were sold at 63.172 billion UAH, of which the volume of products sold abroad was 30.721 billion UAH. Accordingly, the index of industrial products for mechanical engineering for the past year was 102.0, which indicates (for the first time in four years) an increase in output [16].

**6.4. Competition in the domestic market.** In the domestic market, competitive conditions are quite tough. The type of competition is monopolistic, which implies a relatively large number of medium and small manufacturing enterprises offering similar but not identical products. That is, the degree of differentiation is sufficiently high. Consumers show loyalty to this or that trade mark, to qualitative characteristics of the goods. Price competition fades into the background. In general, monopolistic competition contributes to the development of industry, dictates the need for manufacturers to improve the product, increase the number of assortments and the like. Let's emphasize that in the monopolistic competition it is important to differentiate the goods, in particular, the formation of the brand. A bright confirmation that in Ukraine creates a well-known brand is you can name of such manufacturers of devices as «Steklopribor», «Ecosoft», «Arsenal» and others [19].

A serious obstacle for Ukrainian producers is the presence of a large number of European (buyers consider them better when selecting analogs) and Asian products (competitors are priced according to the price criterion, since the cost of labor is less local) in the market.

## 7. SWOT analysis of research results

*Strengths.* Strengths for the instrument-making industry in the study are the availability of highly skilled labor

and development of science, which allows to reduce the cost of production with ensuring a consistently high level of its quality.

*Weaknesses.* Weakness is a cluster of supporting industries, which, in the presence of development prospects, requires investment and demand conditions in the domestic market, which reduce the overall quality of products through price competition.

*Opportunities.* Opportunities for development of the industry are the attraction of monetary assets under the programs of NEFCO, IQ-Energy, ESCO, etc., which will enable the industry to develop in the presence of strong domestic producers.

*Threats.* Threats are the presence of a large number of foreign competitive firms that can use the national brand as a quality criterion (goods of the European Union) or low prices (East Asian products).

## 8. Conclusions

1. The estimation of the current state of the instrument-making industry through the dynamics of exports and imports over a ten-year period is given, in the course of which the strengthening of the import orientation of the industry along with the fall in exports is revealed.

2. The analysis of the determinants of competitiveness by the method of M. Porter's diamond of the national advantages has been carried out to identify the prerequisites and causes of the above-mentioned trends. The following determinants that hamper the development of the industry are determined: the weakening of the raw material base for the unfavorable political and economic situation (the inability to extract or transport raw materials in the occupied territories) and the underdevelopment of infrastructure in small towns;

Weakening of the cluster of supporting industries due to inefficient policies for their development; rigid monopolistic competition in the domestic market due to the presence of a significant number of imported goods of appropriate quality. It is determined that positive factors of influence on the industry are: availability of relatively cheap highly skilled manpower and scientific potential in Ukraine, as well as the possibility of attracting financial investments in the industry.

To improve the state of instrument-making in Ukraine, the following activities are proposed:

- improving the image of domestic goods, building consumer confidence, creating strong Ukrainian brands that could compete with foreign ones;
- attracting domestic private investors, creating a favorable investment climate;
- creating or restoring the elements of a cluster of supporting industries, having previously justified the economic feasibility (taking into account the potential and real capabilities of each of them);
- introduction of new developments, know-how in the manufacture of products (for example, those that reduce cost, improve the quality of products, etc.);
- further development of the production infrastructure;
- stimulating the consumer to increase the consumption of domestic manufactured goods;
- reduction of taxes on raw materials and materials for high-tech industries.

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**АНАЛІЗ КОНКУРЕНТОСПОСОБНОСТІ ПРИБОРОСТРОЕННЯ В УКРАЇНІ С ПОМОЦЬЮ РОМБА НАЦІОНАЛЬНИХ ПРЕИМУЩЕСТВ**

Проведен анализ международной конкурентоспособности приборостроения Украины с помощью ромба национальных преимуществ М. Портера. Анализ проводился по таким показателям, как: факторные условия (человеческие ресурсы, природные ресурсы, финансы, технологии, инфраструктура), кластер поддерживающих отраслей, спрос на внутреннем рынке и конкуренция на внутреннем рынке.

**Ключевые слова:** приборостроение Украины, применение ромба Портера, международная конкурентоспособность приборостроения.

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