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DIGITAL PATH OF INDUSTRIAL DEVELOPMENT IN THE REPUBLIC OF BELARUS

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***Abstract.** The article discusses the theoretical foundations of digitalization, highlights the main advantages and current trends in the digital transformation of industry. The aim of the work is to study the relationship between the introduction of digital and innovative technologies in the industry and the change in the studied indicators. The relevance is reflected in the analysis of the impact of digital transformation and innovation on the main indicators of industrial development in the Republic of Belarus. As a result of the conducted research, the advantages and prospects of development, as well as the problems facing the transformation of the industry, are identified.*

***Keywords:** digitalization; digital transformation; innovative activity; industry; manufacturing industry; «Industry 4.0».*

I. INTRODUCTION

In the modern world is clearly visible digital transformation of the economy, which seeks to provide opportunities for the development of society, new ideas and discoveries, to improve the quality of life, to ensure higher safety standards, to empower healthcare, to allow products and services of higher quality, to promote environmental protection.

The essence of digital transformation is reduced not only to the large-scale use of information and communication technologies, but also to the main goal-to transfer the economy to a new level of economic, technological and social development based on innovation.

The main driving forces today are new products and services, the latest information and management technologies, innovative business models and industry-specific digital platforms.

One of the latest trends in the modern world in the development of digital transformation of the economy is «Industry 4.0» – the integration of the links of the industrial production chain using «the latest information and communication technologies». In developed countries, development has moved a step forward and is moving towards «Society 5.0» – the development of technologies aimed at creating an accessible connection between people and technology.

II. LITERATURE ANALYSIS

The term «digital economy» was first used by Don Tapscott, a Canadian researcher at the University of Toronto, in his book of the same name, The Digital Economy in 1994.

Later, in 1995, Nicholas Negroponte, a computer scientist and founder of the Media Lab at the Massachusetts Institute of Technology, introduced the phrase to the scientific community. [1]

For the first time, the concept of «Industry 4.0» was introduced by German scientists – Kagerman, Lukas and Walster in 2011, when the German government raised the question of the need to expand the use of information technologies in production.

Later, in 2016, the founder of the World Economic Forum, Klaus Schwab, introduced the term into mass use. In his book «Technologies of the Fourth Industrial Revolution», he confirms that «Industry 4.0» is a close concept to the fourth stage of the industrial revolution [2].

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

The object of the study was the industrial complex of the national economy of the Republic of Belarus.

The subject of the research is digital processes of industrial transformation.

The following research methods were used: study of the literature on the research topic, analysis and synthesis of information, measurement and analysis of statistical data, generalization of the data obtained.

IV. RESULTS

The global digitalization of the economy is seen as a driving force for economic growth, which can lead to significant economic shifts and have an impact on entire areas of business, the labor market and the way of life of people.

The term «digitalization», used in the manufacturing sector, implies the implementation of measures and measures aimed at making production more flexible, adapted to modern requirements and competitive in the «digital world».

One of the latest trends of the modern world in the development of digital transformation of the economy is «Industry 4.0» or «The Fourth Industrial Revolution», which is the integration of the links of the industrial production chain using «the latest information and communication technologies».

The central element of the functioning of production systems is the Internet technology, which provides communication between people, machines and products.

«Industry 4.0» defines the vision and principles of the «Smart Enterprise». Such an enterprise uses a modular structure, cyber-physical systems manage physical processes, creating a kind of virtual copy of the real world, and make decentralized decisions.

Thus, the authors of the Sretensky Club claim that «Industry 4.0» as part of the digital economy is the era of the «industrial Internet of things», in which there will be full access to every stage of production using a global network and sensors [3].

The development of practical experience has led to the understanding that «Industry 4.0» is a complete transformation of production, affecting both the management mechanisms and the production process itself, from the supply of raw materials to sales.

It is worth noting that many developed countries have reached a new level in this direction and are following the path of development of «Society 5.0», which is focused not on digital transformation, but on people's communication and created digital technologies.

The Republic of Belarus is at the stage of transition to Industry 4.0, so it is necessary to pay attention to the main features and characteristics of the digital transformation of the industry, which has already been implemented and is currently in the plans for implementation in the economy.

The analysis of the relationship between the introduction of digital and innovative technologies in the industrial sector and changes in the studied industrial indicators is carried out. The data for the study are taken from the official website of the National Statistical Committee of the Republic of Belarus [4].

There are several areas in which the dynamics can be traced most clearly:

- the number of innovative and active organizations in the total number of;
- structure of expenditures on technological innovations;
- the volume of innovative products shipped by industrial organizations;
- dynamics of the receipt of patent applications and their issuance;
- the structure of the volume and gross value added of industrial production by the level of manufacturability.

Digitalization in the industrial sector is reflected in the transition from the raw materials and industrial economy to a new form based on information and communication technologies and the latest achievements of scientific and technological progress, with the predominant role being taken by innovation, intellectual labor, information goods and services.

The introduction of new digital technologies and the formation of innovative and technological production directly depends on the research activities carried out. Therefore, it is worth studying the number of innovative and active industrial organizations.

The analysis of their number and share in the total number of innovative organizations will allow us to assess the compliance of the industry sector with the trends of digital transformation of the economy.

The current trend and the relationship can be judged by the dynamics of the indicators in Table 1. Graphically, the information is presented in Figure 1.

Table 1. The dynamics of innovation-active organizations of the industry

Indicators	Number of innovation-active organizations, units			The share of innovation-active organizations in the total number of surveyed organizations, percent		
	2017	2018	2019	2017	2018	2019
Years						
Industry	347	380	405	21.0	23.3	24.5

The number of innovation-active organizations has a positive growth rate of 16.7% over three years. The share of the total number of organizations surveyed increased by 3.5 percentage points.

The positive dynamics indicates an increase in demand for innovative and technically advanced products, which encourages enterprises to apply the latest achievements of digitalization and scientific and technological progress, improve technological processes, thereby becoming innovative and active.

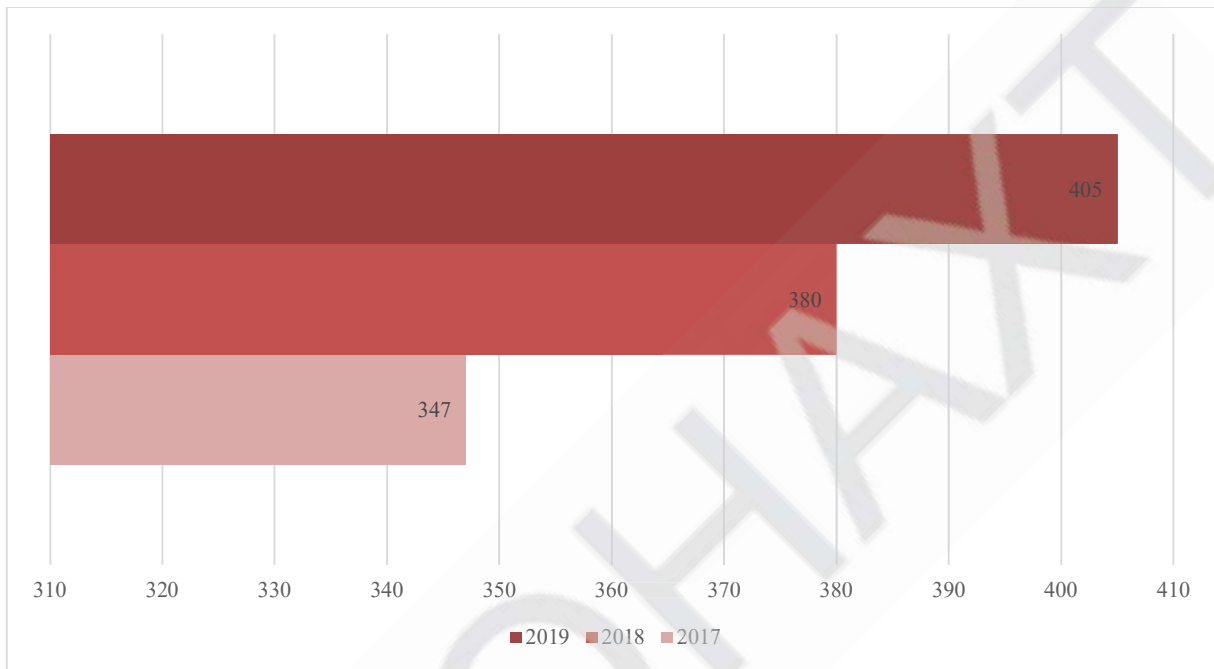


Fig. 1. The dynamics of innovation-active organizations of the industry

Indicators of the costs of technical innovations can serve as an indicator of the growing demand for the restructuring of innovative organizations in the context of the digital transformation of the economy. Analyzing the cost structure, you can make an analysis of the directions of development of organizations. The data is presented in Table 2 and Figure 2.

The structure of total costs for five years has changed in a positive direction – the growth rate was 30.9 %.

The growth rate of innovative products responsible for the development and implementation of technologically new and technologically advanced products was 27.6 %. And the growth rate of technological innovations, including the development and implementation of technologically new and improved production methods, was 36.1 %.

If you look at the share of innovation in costs, product innovation still holds the leading position, having decreased by 1.6 percentage points in five years due to the increased cost of technological innovation.

Table 2. Dynamics of the cost structure for technological innovations in industrial organizations (bel. rub)

Indicators	2015	2016	2017	2018	2019
Costs of technological innovation	1 061.7	774.6	1 222.6	1 134.9	1 390.3
product innovations	645.3	405.1	951.4	846.4	823.5
process innovation	416.4	369.5	271.1	288.5	566.8
Costs of technological innovation (as a percentage of the total)	100	100	100	100	100
product innovations	60.8	52.3	77.8	74.6	59.2
process innovation	39.2	47.7	22.2	25.4	40.8

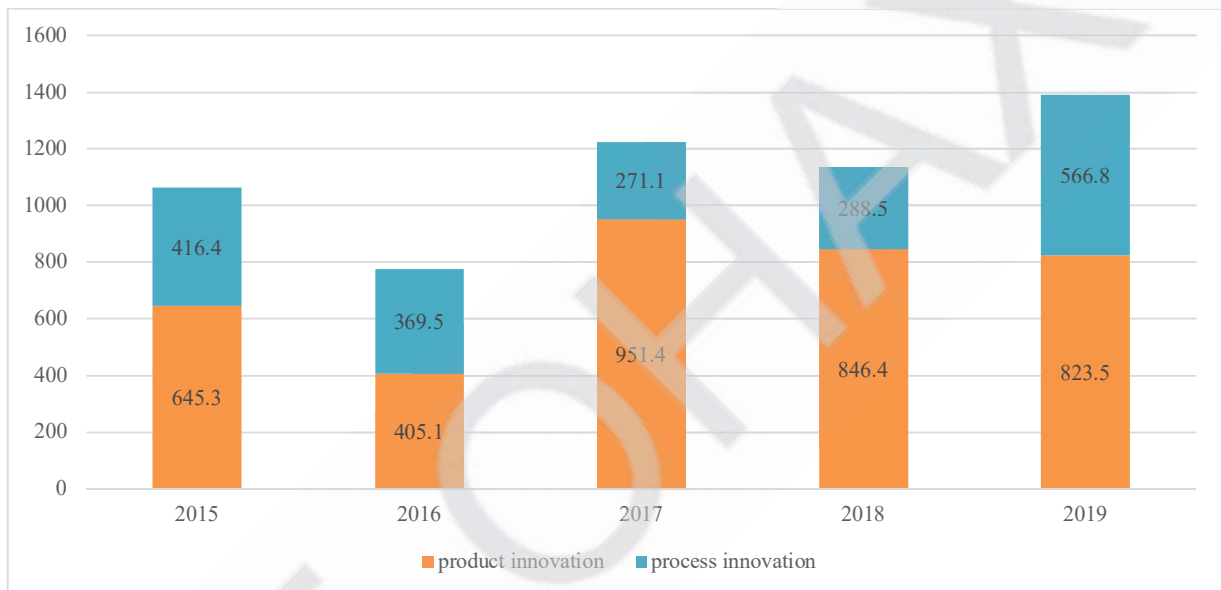


Fig. 2. Dynamics of the cost structure for technological innovations in industrial organizations (bel. rub)

Therefore, we can judge the positive dynamics of the costs of technological innovations, which are also associated with digital transformation. This trend allows enterprises to produce higher-quality and technically new products, improving their own production and increasing their competitiveness in the market.

One of the factors of a successful transition to a digital and innovative economy is the volume of innovative products shipped. The analysis allows you to evaluate the effectiveness of innovative and active organizations. The dynamics of the indicators are presented in Table 3 and Figure 3.

The growth rate for three years of the volume of shipped innovative products was 17.2 %, but compared to 2018, it decreased by 5.4 %. This was also reflected in the decrease in the specific weight in the total volume of products shipped.

Innovative products are usually understood as new products for the external market. Products are considered new on the market for no more than three years, after which they lose their competitive qualities.

Table 3. Dynamics of the volume of innovative products shipped by industrial organizations

Indicators	The volume of innovative products shipped, million rubles			Specific weight in the total volume of products shipped, as a percentage		
	2017	2018	2019	2017	2018	2019
Industry	13 040.7	16 171.0	15 288.7	17.4	18.6	16.6

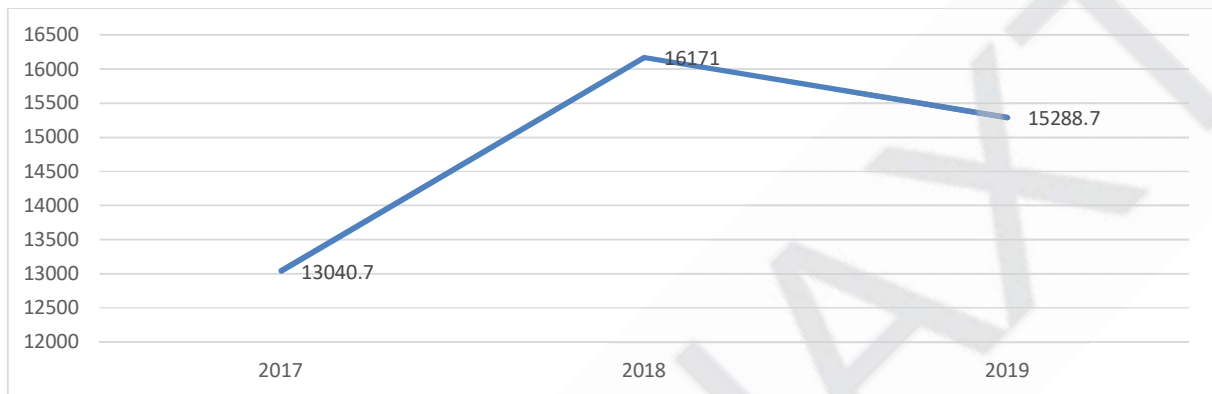


Fig. 3. Dynamics of the volume of innovative products shipped by industrial organizations

The growth rate for three years of the volume of shipped innovative products was 17.2 %, but compared to 2018, it decreased by 5.4 %. This was also reflected in the decrease in the specific weight in the total volume of products shipped.

Innovative products are usually understood as new products for the external market. Products are considered new on the market for no more than three years, after which they lose their competitive qualities.

The main domestic enterprises that produce newly purchased products and have the largest share in the volume of products going to the foreign market are enterprises of the chemical industry, the production of machinery and equipment, and the potash industry.

Any changes in the system of production and sales of products directly affect the volume of innovative products shipped.

The development of innovative products can be hindered by a number of negative factors that affect the level of development of the industry as a whole.

Among them: wear and tear and insufficient working capital, low productivity and high production costs, the presence of a large stock of finished products in warehouses, a low level of quality management system, low competitiveness and other factors that hinder sales in foreign markets.

The negative trend may also be the result of a decrease in the receipts and issuance of patents, data for which are presented in Table 4 and Figure 4.

The number of applications submitted in three years has increased by only 4.3 %, and this figure has increased due to an increase in the number of foreign applicants. The number of issued patents decreased by 33.5 %, and the number of active patents – by 21.9 %.

Table 4. Dynamics of patent application receipts and grant of patents (units)

Indicators	2016	2017	2018
Applications for patenting of inventions were filed, total	521	524	547
National applicants	455	434	454
Foreign applicants	66	90	93
Patents for inventions issued, total	941	850	625
National	892	772	524
Foreign	49	78	101
Valid for patents	2 735	2 414	2 135

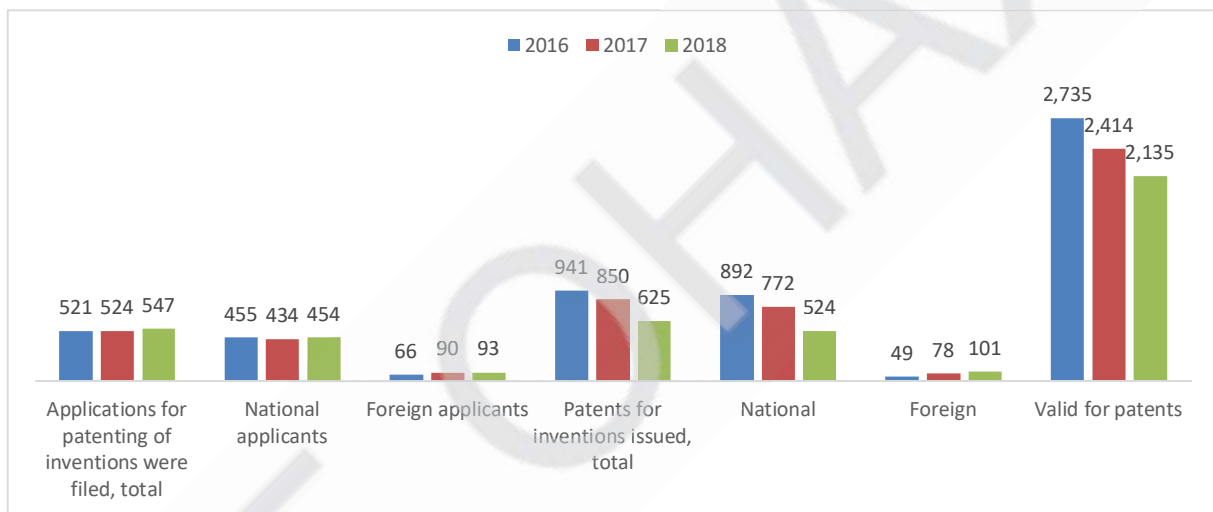


Fig. 4. Dynamics of patent application receipts and grant of patents (units)

The decline is a negative factor of innovation activity, indicating the non-participation of researchers and practitioners in the creation of new inventions, utility models and industrial designs, and also indicates a general low level of innovation activity and, as a result, indicates unfavorable conditions for conducting scientific research.

Low readiness of industrial production for digital transformation and the production of innovative products will be observed until a number of issues are resolved to improve the organization of enterprises and create favorable conditions for the development of innovative activities.

The state of digital transformation in the industrial sector can also be studied on the example of indicators of industrial production in terms of technological efficiency, as well as the gross value added of the largest segment – the manufacturing industry. The dynamics over the past five years allows us to study the degree of integration of advanced technologies and modern principles of business process organization in production.

In the Table 5 and Figure 5 shows the dynamics of the share of manufacturing industry in the total volume of industry by the level of manufacturability, divided into low -, medium - and high-tech industries.

According to the data obtained, the structure of production has changed slightly compared to the base year, so the previous values of the shares remained in low - and high-tech industries.

Table 5. Changes in the structure of industrial production by level of technological efficiency (as a percentage of the year-end)

Indicators	2015	2016	2017	2018	2019
Industry, total	100	100	100	100	100
the manufacturing industry in terms of technological efficiency:					
low-tech manufacturing	33.9	35.1	34.5	32.9	33.9
medium-tech production (low-level)	29.5	27.7	29.5	30.5	29.2
medium-tech production (high-level)	20.8	20.0	21.1	22.4	22.8
high-tech production facilities	2.8	2.9	3.0	2.8	2.8

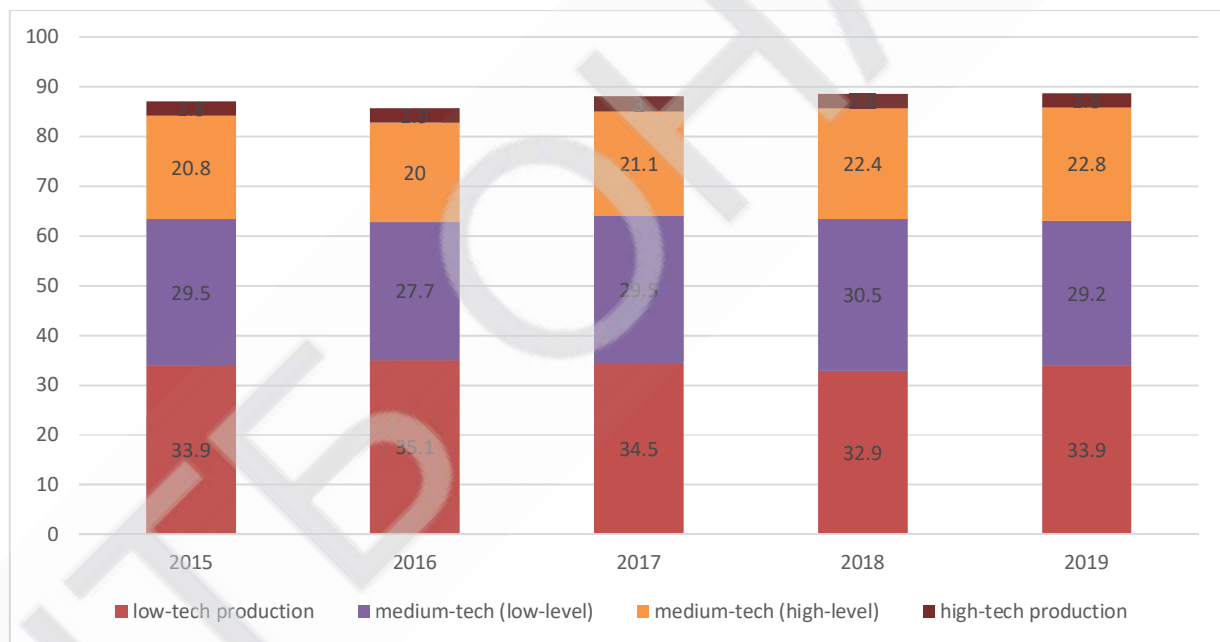


Fig. 5. Changes in the structure of industrial production by level of technological efficiency (as a percentage of the year-end)

It is worth noting that for five years, the share of high-tech industries remains the lowest, while low-tech manufacturing has the highest share. This trend indicates the predominant use of low technologies, low production efficiency and low competitiveness of products belonging to the «traditional» category.

However, the positive dynamics can also be traced in the average level of technological efficiency: low-level medium-tech production decreased by 0.3 percentage points, and high-level production, on the contrary, increased by 2

percentage points by 2019. The share of technological production in the manufacturing industry increased by 1.7 percentage points from 87 % in 2015 to 88.7 % in 2019. This slight increase indicates a slow but steady transition to an increase in industrial production with higher technological efficiency.

An important indicator that characterizes the processes of digital transformation of the economy is the share of gross value added (hereinafter – GVA). Table 6 shows the dynamics of the GVA structure only in the manufacturing industry by the level of manufacturability.

Table 6. Dynamics of the structure of the gross value added of the manufacturing industry by the level of manufacturability (percent)

Indicators	2015	2016	2017	2018	2019
Manufacturing industry	100	100	100	100	100
low-tech manufacturing	35.8	41.9	39.2	39.2	38.3
medium-tech production (low-level)	24.6	23.0	22.8	20.2	21.4
medium-tech production (high-level)	34.9	29.5	32.5	35.3	35.2
high-tech production facilities	4.7	5.6	5.5	5.3	5.1

The state is interested in increasing the GVA as a source of filling the budget with employees, since wages are an integral part of this indicator. Entrepreneurs are interested in profit, which is also included in the GVA, since it creates conditions for expanding production.

High-tech production allows you to create products with the highest added value, thereby creating positive factors for the sale of such goods and services. Compared to 2015, this indicator increased by 0.4 percentage points, taking a share of 5.1 % of the total volume.

Despite the fact that the preservation of low-tech production makes it difficult to switch to more high-tech products, its share in the GVA structure is growing and is the largest (increased by 3.5 percentage points). In terms of the share of gross value added, the second place is occupied by high-tech medium-tech production, the difference between the indicators in 2019 was 3.1 percentage points.

Both in terms of industrial output and the share of gross value added, low-level medium-tech production is declining (by 3.2 percentage points), while high-level production is growing (by 1.3 percentage points).

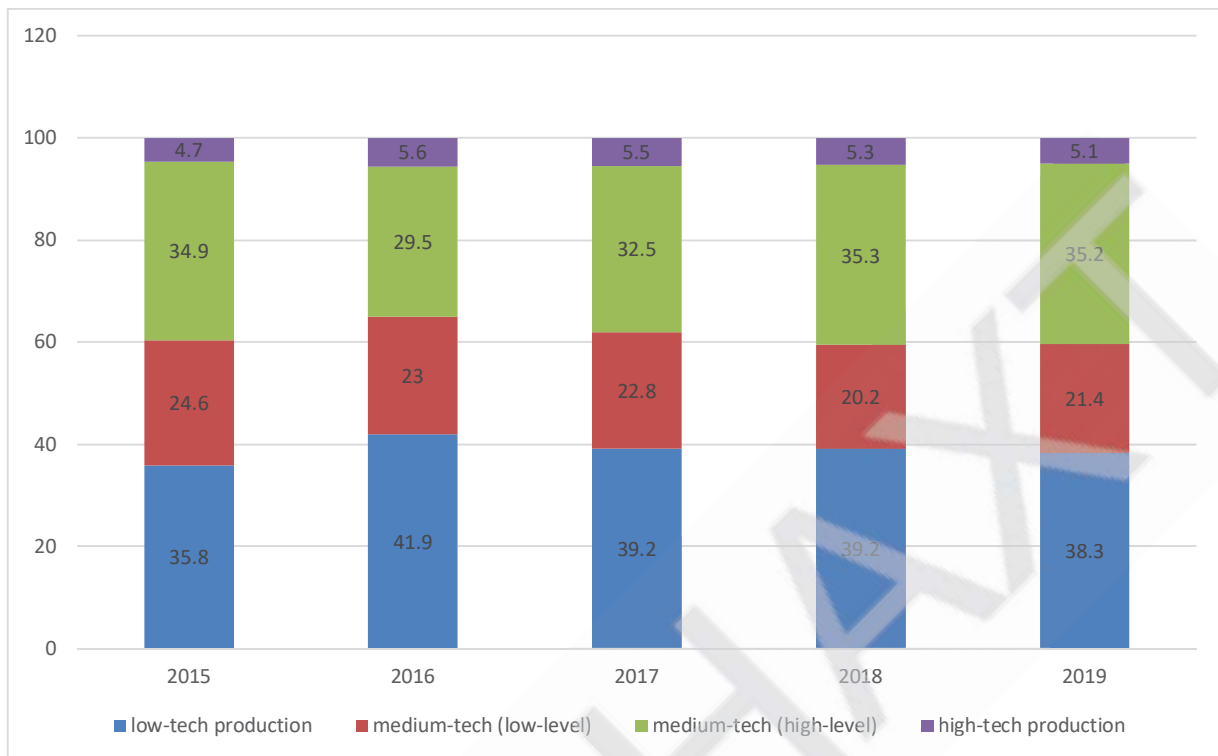


Fig. 6. Dynamics of the structure of the gross value added of the manufacturing industry by the level of manufacturability (percent)

V. CONCLUSIONS

Thus, it should be concluded that digitalization can be defined as a modern innovative stage of economic development that allows you to rebuild modern production, solving a whole range of important tasks: improving the quality and efficiency of goods and services, improving security and reliability, increasing the flexibility of business processes and consumer response, product launch speed and accelerated information processing.

In the course of the work, the main directions of the digital transformation of the industry through the introduction of new innovative technologies were identified. When further analyzing the data on the dynamics of digital processes in the industry, the following conclusions were made:

Indicators of the volume of production and gross value added of the manufacturing industry are important indicators that demonstrate the development and adaptation of industrial production in the context of economic transformation, the transition to a new level of innovative technologies based on digitalization.

The volume of manufactured and shipped products is growing not only in the context of the national market, but also in the external market, so the products are competitive. This factor can also be attractive for investors and individuals from abroad, which will allow them to finance production.

A general conclusion can be drawn about the growing digital transformation of the industrial sector, which is expressed in an increase in the number of innovation-active organizations and the positive dynamics of production and technological costs.

However, it is worth noting the decline in the rate of shipment of innovative products and the slow transition to high-tech production.

The reflected dynamics of the indicators in general allowed us to draw conclusions about the development prospects and predict further improvement of the indicators, as well as to present the challenges and problem areas in the industries that need to be paid attention to when developing state programs to support the development of digital transformation.

Thus, the total volume of output can serve as a conclusion about the need to follow the global trends of digitalization and develop programs and conditions for creating new sectors of the digital economy, production and service organizations to a new level of work in the context of widespread penetration of electronic and network technologies.

The state needs to support small and medium-sized businesses in the development of the digital economy, take measures that will allow enterprises that have been operating in the market for a long time to adopt and implement global trends.

At the state level have been developed and implemented such programs support the digitalization of «State program for the development of the digital economy and information society for 2016-2020», the Decree № 8 «On the development of the digital economy», the «National strategy for sustainable development–2030», and supported the main subject of the innovative infrastructure, high-tech Park.

Implementation of state programs contributes to the formation and rapid development of high-tech sectors of the economy, strengthening the position of the country in high-tech markets, the competitiveness of traditional sectors of the economy on the basis of their innovation development and the introduction of advanced technologies, the formation of market research products and favorable innovative environment.

The Republic of Belarus has real opportunities for the development of an economy based on knowledge, information and digitalization with the rational and full use of all elements of the national innovation system.

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