Digitalization and ITS relationship with innovative development of the economy

Bartosz Mickiewicz \(^{A}\); Katsiaryna Volkava \(^{B}\)

\(^{A}\) West Pomeranian University of Technology, 17, Piastow str., Szczecin, 2009, Poland
\(^{B}\) Belarusian State University of Food and Chemical Technologies, 3, Shmidtta str., Mogilev, 1973, Belarus

Received: April 21, 2022 | Revised: May 12, 2022 | Accepted: June 27, 2022

JEL Classification: Q17, Q18.

DOI: 10.38188/2534-9228.22.2.04

Abstract

The study is based on a systematic approach to the conditions for the formation and evaluation of the innovative development of the economy. A methodological approach to the innovative development of the economy was developed based on the construction of forecast models that reflect the share of shipped innovative products (foodstuffs), the export of agricultural products and food products, which contribute to the maximum profit of innovatively active organizations and the gross domestic product (GDP) of the agro-food sector. The modern mechanism for increasing the competitiveness of industrial enterprises in the European market is based on an innovative digital model of economic development, the activation of innovative and investment activities, the constant adaptation of enterprises to the conditions of the internal and external environment, taking into account risks and new conditions of digital transformation. It allows you to conduct a comprehensive trend analysis using the selected estimated indicators and taking into account various factors, which allows you to identify reserves for activating the innovative development of the national industrial complex in the context of the formation of the digital economy, in conjunction with the expansion of the use of information and communication services, to justify the areas for the development of innovative activities under conditions of digital transformation of production. The distinction lies in the development of the theoretical and methodological basis of the relationship between the digital transformation of the economy and the innovative development of industry, including the agri-food sector, and in the development of predictive trends.

Keywords: digital economy, innovations, innovative products, industry, level of manufacturability, agri-food sector, assessment, exports, gross domestic product, forecast, development prospects.

Introduction

The goal is to develop theoretical and methodological approaches to the development of the innovative economy of the Republic of Belarus into a new type based on digital transformation, aimed at sustainable economic growth.

General scientific methods of theoretical learning were used in the process of studying the relationship between digital transformation and innovative development of the economy: statistical and logical analysis, synthesis, comparison, deduction and generalization, classification, etc.

The digital transformation of the economy offers excellent prospects for innovative development, which provides a significant contribution to sustainable economic development, increasing the competitiveness
and innovativeness of industry, and the population living standards.

The Global Innovation Index (GII) is the largest index for assessing the level of scientific, technological and innovative development of various countries. Current data for countries is collected annually, the methodology for calculating composite indicators is being improved, and work is underway to supplement the missing data for individual countries of the world in order to calculate the integral GII estimate. At the end of 2019, the generalized GII indicator for the Republic of Belarus amounted to 32.06 points, which corresponds to the 72nd position among 129 countries of the world based on the calculation of 80 indicators (in 2018 – 86th position). The greatest improvement in the position of Belarus in 2019 was observed in four subgroups of indicators: “the impact of knowledge”, “investment”, “information and communication technologies” and “Internet creativity” (Shumilina, A.G., Gusakova, V. G., 2020).

The share of innovative industrial organizations in European countries and in the overall structure is approximately 50%. The following types of innovations are summarized using a systematic approach to the innovative activity of industrial organizations:

– product innovations are aimed at creating new products and improving their quality characteristics;

– process (technological) innovations – that is the development of new technologies, equipment modernization, reconstruction, etc.;

– industrial innovations are focused on expanding production capabilities, diversifying and modernizing production, changing the structure of production;

– economic innovation is a change in the methods and ways of planning all types of activities, stimulation, etc.;

– organizational innovation is the implementation of a new organizational method, in the organization of jobs or external relations;

– managerial innovations are aimed at improving the organizational structure, management decisions, management;

– information innovations are associated with the optimization of information flows, increasing the reliability, accessibility, transparency and efficiency of obtaining various information, etc.;

– marketing innovations are aimed at targeted changes in trade and marketing activities;

– social innovations are the improvement of the conditions and nature of work, the psychological climate, social welfare;

– environmental innovations – improvement of ecology, environment.

It should be noted that all types of innovations are in continuous interconnection and interdependence. Technological innovations influence the content of production processes and simultaneously create conditions for the emergence of economic and managerial innovations, as they make changes in the organization of production.

Groups of industrial types of economic activity are distinguished in international and national statistics according to the level of manufacturability: high-tech production, medium-tech of high level, medium-tech of low level and low-tech ones. At the same time, the first two groups form high-tech production facilities. High-tech production includes the production of basic pharmaceutical products and preparations; production of computing, electronic and optical equipment; production of aircraft, equipment for them. High-level medium-tech production includes the production of chemical products; production of electrical equipment; production of machinery and equipment not included in other groups; production of cars, trailers and semi-trailers; production of other transport vehicles and equipment (Shumilina, A.G., Gusakova, V. G., 2020).

The dynamics of the structure of manufacturing activity by the level of manufacturability in the total volume of industrial manufacturing is given in Table 1.
Table 1 – The structure of manufacturing activity by the level of manufacturability in the total volume of industrial manufacturing, %

| Title                                           | 2017 | 2018 | 2019 | 2019 by 2017, +, - |
|-------------------------------------------------|------|------|------|------------------|
| Manufacturing industry by level of manufacturability: |      |      |      |                  |
| low-tech production                              | 34.5 | 32.9 | 33.9 | -0.6             |
| medium-tech production (of low level)            | 29.5 | 30.5 | 29.2 | -0.3             |
| medium-tech production (of high level)           | 21.1 | 22.4 | 22.8 | +1.7             |
| high-tech production                             | 3.0  | 2.8  | 2.8  | -0.2             |

Source: build by the author

Analysis of the data given in Table 1 showed that in 2019 the main share in the structure of manufacturing activity in terms of the level of manufacturability in the total volume of industrial manufacturing was occupied by low-tech (33.9%) and medium-tech production (of low level) (29.2%). The share of high-tech production in 2019 amounted to 2.8%, which is 0.2% lower compared to 2017, which requires the development of appropriate measures to increase them.

The dynamics of costs for technological innovations in industry is given in Table 2.

Table 2 – Composition and structure of costs for technological innovations in industry

| Title                                           | 2017     | 2018     | 2019     | 2020     |
|-------------------------------------------------|----------|----------|----------|----------|
| Technological innovation costs – total, including: |          |          |          |          |
| product innovations                              | 951.4    | 77.8     | 846.4    | 74.6     | 823.5    | 59.2     | 997.7    | 68.8     |
| process innovations                              | 271.1    | 22.2     | 288.5    | 25.4     | 566.8    | 40.8     | 453.1    | 31.2     |

Source: build by the author

Analysis of the data given in Table 2 showed that in 2020 the main share in the structure of costs for technological innovations was occupied by product innovations (68.8%) and process innovations (31.2%).

Material and methods

In the State Program of Innovative Development of the Republic of Belarus for 2021–2025, solving the tasks to ensure the innovative development of traditional sectors of the national economy at the level of the European Union based on increasing the science linkage of production involves the formation of a technological basis for the innovative development of traditional sectors of the national economy based on the tasks of scientific and technical programs and innovative projects corresponding to high-tech productions based on the V and VI technological modes; digital transformation of traditional sectors of the national economy (State Program of Innovative Development of the Republic of Belarus for 2021–2025).

The digital transformation of the economy can be studied as a modern innovative stage of economic development, which is based on the
integration of physical and digital resources in the field of production and consumption in the economy and society. This stage is characterized by new methods of generating, processing, storing and transmitting information in all fields of human activity. The very concept of “digitalization” indicates a new stage in the development of production management based on the end-to-end use of modern information and communication technologies, ranging from the Internet of things to e-government technologies (Achapovskaya, M., 2019).

At the present stage, innovative development trends are characterized by the restructuring of the economy based on the penetration of information and communication technologies into all spheres and activities. In industry, these changes are usually taken into account with the beginning of the fourth industrial revolution, called “Industry 4.0.” This concept involves the digitalization of the assets of industrial enterprises with the implementation into production and consumption of the so-called cyber physical systems – engineering structures controlled remotely by way of information and communication technologies. The development of the digital economy has a direct impact on the innovative activity of industrial enterprises, accelerating the implementation of technological innovations and reducing the duration of the innovation process (Nekhorosheva, L.N., 2020).

Projected by UN, population growth to 8.3 billion people by 2030, up to 9.7–10.0 billion people by 2050 and up to 11.2 billion people by 2100 (growth occurs exclusively due to developing countries – their share in the world population is growing due to a decrease in the share of developed countries, which was: in 1950 – 32.2%, in 2010 – 17.5%, in 2050 – 13.6%), an increase in per capita consumption of agricultural products and changes in diet are the driving factors of expected changes in food markets. It is assumed that the world GDP will increase by 2.5 times and per capita income by 1.8 times by 2050 (Gospodarik, E.G., Kovalev, M.M., 2015).

**Results and discussion**

An innovatively active enterprise is an enterprise that incurs costs for various types of innovation. In terms of product innovations, the Republic of Belarus is at an average level with the EU countries; in terms of process innovations, it is necessary to ensure an increase in the share of organizations implementing them from 26.5% in 2021 to 35% in 2025 (Gnatyuk, S.N., 2020, Saiganov, A.S., Panteleeva, I.I., 2019).

The dynamics of the share of innovatively active industrial organizations of the Republic of Belarus in the total number of studied industrial organizations is shown in Fig. 1.

The data presented in Fig. 1 show that in 2020 the largest share in the total number of studied industrial organizations in Belarus is occupied by innovatively active organizations in Minsk (in 2020 – 35.1%, which is 3.3% higher than in 2018). Positive dynamics indicates an increase in demand for innovative products, which encourages enterprises to improve technological processes of production based on digital transformation.

The largest share in the structure of organizations engaged in technological innovation is occupied by organizations engaged in production design and other types of production preparation (49.7%), research and development of new products, services and methods of their production (transfer), production processes (40.5 %), purchase of machinery and equipment related to technological innovation (41.6%). In the context of the digital transformation of the economy, there is a low share of organizations for the acquisition of new and high technologies (1.6%), the acquisition of computer programs and databases related to technological innovations (5%) (Science and Innovation Activity in the Republic of Belarus, 2020).
The dynamics of the share of innovatively active industrial organizations of the Republic of Belarus in the total number of studied industrial organizations, %

Source: suggested by the author

The dynamics of the share of innovative products in the total volume of shipped products by industrial organizations of the Republic of Belarus is shown in Fig. 2.

The data presented in Fig. 2 show that in 2020, the largest share of innovative products in the total volume of shipped products by Belarusian industrial organizations is occupied by the Vitebsk region (in 2020 - 32.7%, which is 3.9% higher compared to 2018), Gomel region (in 2020 – 28.1%, which is 9.9% lower compared to 2018) and the city of Minsk (in 2020 – 19.8%, which is 4.9% higher compared to 2018).

The share of exports in the total volume of shipped innovative products by industrial organizations as a whole is shown in Fig. 3.
The data presented in Fig. 3 show that the share of export products in the total volume of shipped innovative products by industrial organizations as a whole in 2020 amounted to 55.8%, which is 5.1% higher compared to 2010, including to the Russian Federation – by 2.1%.

The dynamics of the volume of shipped innovative products by industrial organizations of the Republic of Belarus is given in Table 3.

**Table 3 – Dynamics of the volume of shipped innovative products by industrial organizations of the Republic of Belarus**

| Title                           | 2017          | 2018          | 2019          | Growth rate, % 2019/2017 |
|---------------------------------|---------------|---------------|---------------|--------------------------|
|                                 | thousand RUB  | %             | thousand RUB  | %                        |
| Industry                        | 13040740      | 100           | 16170970      | 100                      | 117.2                    |
| of it: manufacturing industry   | 12997794      | 96.9          | 16114363      | 99.6                     | 117.6                    |
| including the production of     | 564307        | 4.3           | 551220        | 3.4                      | 124.2                    |
| foodstuffs, beverages and       |               |               |               |                          |                          |
| tobacco                         |               |               |               |                          |                          |

*Source: build by the author*

The data in Table 3 shows that the growth rate of the volume of shipped innovative products in the industry as a whole was 17.2%, including in the processing industry – 24.2% during the studied period.

The Republic of Belarus corresponds to the average level of the EU countries in terms of the share of shipped innovative products in the manufacturing industry. With the planned increase in the share of shipped innovative products to 21% in 2025, the growth in the share of new products for the domestic or global market must be increased from 45% in 2021 to 54% in 2025.

Innovations in the agro-food sector are: new agricultural technologies and machinery,
machinery for processing agricultural raw materials, new plant varieties and animal breeds, new fertilizers and plant and animal protection agents, innovative methods for the prevention and treatment of animal diseases, forms of fund raising and lending to agro-industry, modern approaches to training, retraining and advanced training of personnel.

The main innovative technologies in the processing and food industries will be as follows: a digital twin which is a digital analogue of a business, simulating its structure, which will display all aspects from the skills of employees to the market value of products. Thanks to blockchain, the Internet and artificial intelligence, each participant in the supply chain will know exactly how much food needs to be grown and sold, food losses will be reduced, and its quality and availability will increase. Both food producers and consumers will be able to detect pathogens in food with the use of pathogen sensors, which will be either portable or built into mobile phones. Additionally, a method for rapid analysis of the microbial genetics will be developed within five years, with which they can learn about the safety of food and use microbes to protect products (Mickiewicz, B., Efimenko, A., Volkova, E., 2021).

The dynamics of innovative development of the processing industry (by type of economic activity) is given in Table 4.

| Types of economic activity | Share of shipped innovative products in the total volume, % | Share of innovatively active organizations in the total number of studied, % |
|----------------------------|----------------------------------------------------------|----------------------------------------------------------|
|                            | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| Processing and preservation of meat as well as production of meat and meat-containing products | 2.6 | 2.3 | 3.0 | 13.7 | 15.1 | 11.8 |
| Processing and preservation of: fish, shellfish and molluscs | 9.7 | 3.4 | 2.6 | 30.0 | 33.3 | 42.9 |
| fruit and vegetables | 1.3 | 1.0 | 1.0 | 12.5 | 18.8 | 18.8 |
| Manufacturing of: vegetable and animal oils and fats | 1.2 | 2.1 | 1.8 | 14.3 | 12.5 | 12.5 |
| dairy products | 3.4 | 3.7 | 5.0 | 19.2 | 25.5 | 35.4 |
| bakery, noodle and flour confectionery products | 5.5 | 2.9 | 1.5 | 18.0 | 18.5 | 13.2 |
| cocoa, chocolate and sugar confectionery | 15.9 | 15.3 | 14.1 | 28.6 | 57.1 | 50.0 |
| homogenized food preparations and dietetic food | 14.2 | 12.2 | 9.4 | 66.7 | 66.7 | 66.7 |

Source: build by the author

The data in Table 4 show that in 2019 the share of shipped innovative dairy products was 5%, which is 1.6% higher compared to 2017; cocoa, chocolate and sugar confectionery – 14.1%.

The forecast of shipped innovative products for 2021–2025 can be easily prepared. For this purpose, let us construct a trend equation; in order to do that, we choose a polynomial growth curve of the third degree, since it more accurately reflects the dynamics of the original time series (R-squared value = 0.9447) (Fig. 4).
Let us calculate the predicted value using the equation obtained on the diagram (Table 5).

**Table 5 – Forecast value of the share of shipped innovative products (foodstuffs, beverages and tobacco products)**

| Title                                      | 2021 | 2022 | 2023 | 2024 | 2025 | Growth rate, 2025/2021, % |
|--------------------------------------------|------|------|------|------|------|--------------------------|
| Share of shipped innovative products, %    | 1.45 | 1.46 | 1.72 | 2.26 | 3.1  | +1.65                    |

**Source:** build by the author

Calculations showed that the share of shipped innovative products will increase to 3.1% by 2025. The growth rate will be higher by 1.65% compared to 2021.

The data in Table 6 shows that the growth rate of volume of foreign trade in agricultural and food products in 2019 was 6.7% compared to 2017, including an 11.4% increase in exports.

Let us carry out the forecast for the export of agricultural products and food products for 2021–2025. For this purpose, let us construct a trend equation; in order to do that, we choose a polynomial growth curve of the second degree, since it more accurately reflects the dynamics of the original time series (R-squared value = 0.9447) (Figure 5).

The dynamics of the volume of foreign trade in agricultural products and foodstuffs is given in Table 6.

**Table 6 – Dynamics of the volume of foreign trade in agricultural products and foodstuffs, million USD**

| Title                              | Years      | Growth rate, %, 2019/2017 |
|------------------------------------|------------|--------------------------|
| Foreign trade in agricultural products and foodstuffs | 2017 | 2018 | 2019         | 106.7 |
| – export                           | 4971.2     | 5280.1                   | 5536.8 | 111.4 |
| – import                           | 4583.8     | 4424.4                   | 4655.8 | 101.6 |
| – balance                          | 387.4      | 855.7                    | 881.0  | 227.4 |

**Source:** build by the author
Let us calculate the predicted value using the equation obtained on the diagram (Table 7).

### Table 7 – Forecasted value of the export of agricultural products and foodstuffs

| Title                                      | 2021  | 2022  | 2023  | 2024  | 2025  | Growth rate, 2025/2021, % |
|--------------------------------------------|-------|-------|-------|-------|-------|--------------------------|
| Export of agricultural products and foodstuffs | 6671.8| 7624.3| 8763.4| 10089 | 11601.2| 173.9                    |

*Source:* build by the author

Calculations showed that the growth rate of exports of agricultural products and food products by 2025 will be 73.9% compared to 2021.

At the present stage, innovations are considered as the main source of world economic growth, including gross domestic product. The effect will be most noticeable in the manufacturing industry as well as in the retail and services sectors. Upon reaching the planned level of digitalization of 20% in the manufacturing industry by 2025, GDP growth is predicted by about 1%, in retail trade – by 0.92% and in the service sector - 2.2% of the GDP of the countries of the Eurasian Economic Union (Digital transformation, European Commission 9, 2022).

The innovative development of the agro-food sector (agro-industrial complex) is closely related to the intensification of its investment activity (Table 8).

### Table 8 – Evaluation of the effectiveness of investment activities

| Title                                      | Years | Growth rate, % 2020/2016 |
|--------------------------------------------|-------|--------------------------|
| Investments in fixed assets, trillion RUB  | 2016  | 2017  | 2018  | 2019  | 2020  |                        |
|                                            | 18.7  | 21.03 | 25.0  | 28.8  | 29.6  | 158.3                   |
| Investments in fixed assets of the agro-industrial complex, trillion RUB | 1.7   | 2.2   | 2.4   | 3.1   | 3.5   | 205.9                   |
| GDP of the Republic of Belarus, trillion RUB | 94.9  | 105.7 | 122.3 | 134.7 | 139.1 | 146.6                   |
The analysis of the data in Table 8 reflects an increase in the volume of investments in the fixed capital of the agro-industrial complex by 105.9% in 2020 compared to 2016. The efficiency of the investment activities of organizations of the agro-industrial complex decreased by 6% over the same period. In general, the volume of investments in fixed assets significantly exceeds the growth in the volume of production in the agro-industrial complex over the period under study, which indicates a decrease in their efficiency and the development of areas for growth in the GDP of the agro-industrial complex, taking into account innovations.

Let us construct a trend equation; in order to do that we choose a polynomial growth curve of the second degree, since it more accurately reflects the dynamics of the original time series (R-squared value = 0.9672).

Forecast of growth of GDP of agri-food sector of the Republic of Belarus is shown in Figure 6.

![Figure 6 – Forecast of growth of GDP of agri-food sector of the Republic of Belarus](image)

Let us calculate the predicted value of GDP using the equation obtained on the diagram (Table 9).

| Title | Forecast value | Growth rate, % 2025/2020 |
|-------|----------------|--------------------------|
| GDP in the agro-industrial complex, trillion RUB | 10.6 | 11.3 | 12.1 | 12.8 | 13.5 | 127.9 |

Source: build by the author
Calculations showed that the growth rate of GDP in the agri-food sector will be 27.9% by 2025 compared to 2021.

**Conclusions**

Based on the analysis, it was established that the agro-food sector belongs to the dynamically developing sectors of the economy of the Republic of Belarus. This is due to demand factors, including population growth and growth in income, consumer orientation towards high-quality, healthy, functional and specialized nutrition on the one hand, and by the potential of commodity producers on the other hand, which is characterized by the ability to transform under the influence of consumer preferences, high degree of concentration of investment resources, innovative activity and the formation of sustainable competitive strategies. The prospects for innovative development of the agro-food sector are as follows: the activation of innovative activity, the growth of costs for the acquisition of new and high technologies, computer programs and databases, the increase in the investment attractiveness of innovative projects based on the implementation of information technologies. A single market for agri-food products, services, capital without barriers and restrictions can only be formed through the digital transformation of business and control based on digital transparency.

Solving the tasks of expanding the presence and consolidating the position of the Republic of Belarus in the world markets of science-intensive and high-tech products involves the development of mutually beneficial international scientific, technical and innovative cooperation with the attraction of world-class technologies and foreign investments in the scientific, scientific and technical and innovative fields of the economy; diversification of the nomenclature and geographical structure of exports of science-intensive and high-tech products.

**References**

State Program of Innovative Development of the Republic of Belarus for 2021–2025 [Electronic medium]. – Access mode: https://president.gov.by. – Access date: 12.02.2022.

Achapovskaya, M. (2019). Digitalization of the Economy as a Driver of Innovative Development // Bank Bulletin– P. 52–58.

Nekhorosheva, L.N. (2020). Designing the Future: New Risks, Promising Business Models, Economic Intellectualization Strategies. // World Economy and Business Administration of Small and Medium-sized Enterprises: materials of the 16th International Scientific Workshop held within the framework of the 18th International Scientific and Technical Conference “Science for Education, Production, Economy,” – Minsk, 2020. – p. 28–31.

Gospodarik, E.G., Kovalev, M.M. (2015). EAEU-2050: Global Trends and Eurasian Economic Policy. Minsk: BSU Publishing Centre.

Shumilina, A.G., Gusakova, V. G. (2020). On the State and Prospects for the Development of Science in the Republic of Belarus Following the Results of 2019: an analytical report /– Minsk: SU “BelISA”– 396 p.

Gnatyuk, S.N. (2020). Digital Economy as a Driver of Sustainable Development of Belarus // Modern Problems and Ways to Improve the Competitiveness of Business: materials of the International Research-to-Practice Conference – M.: Autonomous non-profit organization of higher education “Institute of Business and Design,” – P. 8–17.

Saiganov, A.S., Panteleeva, I.I. (2019). Theory and methodology of improving the economic mechanism of innovative development of processing organizations of agro-industrial complex: monograph – Smolensk: 256 p.
Science and Innovation Activity in the Republic of Belarus, (2020). [Electronic medium]. – Access mode: https://www.belstat.gov.by/. – Access date: 11.02.2022.

Digital transformation, European Commission [Electronic medium]. – Access mode:https://www.eurasiancommission.org/ru/act/dmi/workgroup/material/dokumen. – Access date: 12.02.2022.

Mickiewicz, B., Efimenko, A., Volkova, E. (2021). Innovative Development of the Food Sector in the Republic of Belarus and Poland: Status and Current Development Trends // European Research Studies Journal, Volume XXIV, Issue 3– S. 774–784.