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CHEMICAL PRODUCTION MODERNIZATION IN THE FORMATIVE PHASE OF INDUSTRY 4.0: STUDY OF TRENDS AND PROBLEMS OF INVESTMENT SUPPORT

Об'єктом дослідження є процеси інвестув нння модерніз ції хімічного виробництв . Трив л системн криз в укр їнській хімічній г лузі, збитковість т висок к піт лоємність виробництв є стримуючими чинник ми її к рдин льної модерніз ції. Суч сні з вд ння цифровіз ції виробництв і впров дження см рт-іннов цій формують нові проблеми т потребують нових підходів до їх вирішення.

У процесі дослідження використовув лися методи н лізу й синтезу, порівняльного співст влення, структурного н лізу, уз г льнення т гр фічний метод.

Проведений н ліз з рубіжної пр ктики іннов ційного інвестув ння хімічного виробництв виявив, що стр тегії розвитку комп ній т їх інвестиційні пріоритети з леж ть від ролі сегменту у глоб льному л нцюзі дод ної в ртості. Лідери г лузі диверсифікують портфелі інвестицій у н прямку високих технологій глибокої переробки і виробництв н укоємної м лотонн жної продукції. Водноч с невід'ємною скл довою їх іннов ційно-інвестиційних стр тегій ст ють технології Індустрії 4.0 т см рт-виробництв .

Дослідження тенденцій і проблем інвестиційного з безпечення укр їнського хімічного виробництв пок з ло, що його тр диційн бізнес-модель поступово втр ч є свою ресурсну т технологічну основу, всередині г лузі відсутні дост тні інвестиції для м сшт бної модерніз ції. Для зовнішніх інвесторів певний інтерес предст вляють окремі сегменти хімічної індустрії, що виробляють ліквідну диференційов ну м лотонн жну продукцію споживчого призн чення.

В ході дослідження визн чено перспективні підходи до ктивіз ції інвестиційної діяльності у хімічній промисловості в контексті ст новлення Індустрії 4.0. Вони ґрунтуються н особливій ролі хімічного виробництв як пост ч льник «розумних» м тері лів і технологій, що перетворює його н необхідний скл дник будь-якої іннов ційної екосистеми. Пок з но, що зовнішні інвестиції для см рт-модерніз ції г лузі треб шук ти серед г лузей-спожив чів хімік тів.

Обґрунтов но, що ключовим суб'єктом процесів Індустрії 4.0 в укр їнській хімічній промисловості м ють ст ти підприємств м лого т середнього бізнесу. Вр ховуючи недост тню технологічну підготовленість т інвестиційне з безпечення т ких суб'єктів, потрібн їхня спеці лізов н підтримк т прогр мне фін нсув ння.

З пропонов ні підходи дозволяють подол ти н явну внутрішню т зовнішню обмеженість фін нсових ресурсів т мобілізув ти інвестиції для з пуску см рт-модерніз ції хімічного виробництв .

Ключові слова: *модерніз ція хімічного виробництв , інвестув нння іннов ційного розвитку, процеси Індустрії 4.0.*

1. Introduction

Industry 4.0 is a new modern paradigm of industrial development, it forms models for the problem-solving of the Industrial Internet of Things and processes their solutions in various industrial sectors. According to the findings of experts from the international consulting company PricewaterhouseCoopers, «The buzz around Industry 4.0 has moved from what some saw as PR hype in 2013 to investment and real results today» [1].

Gradually, the conceptual ideas of Industry 4.0 are included in the agenda of Ukraine. Thus, the promotion of digitalization of industry and its transition to the principles and fundamentals of the Industry 4.0 concept is one of the topical directions for implementing the Strategy for the development of the industrial complex of Ukraine for the period up to 2025 within the framework of the strategic objective «Modernization and growth of industrial production». The essence of this direction, the developers of the project Strategies see in the «digitization of all tangible assets and integration into digital ecosystems and value chains of the partner countries» [2].

It is clear that the modernization of the industry, in particular, digital, requires significant investment resources. In the same Strategy, among the main areas of implementation, the first one is titled «Attracting external and domestic investment in industry», where involvement in the production of foreign direct investment (FDI) is considered as the main condition for modernizing the industry, ensuring the competitiveness of industrial producers and integrating them into global value chains. However, while «systemic problems of the investment field» are stated, the fall in capital investments in the industry of Ukraine is 65.2 % compared to 2013 and the

inflow of the bulk of FDI in the financial and insurance sectors.

To overcome these negative processes, it is planned to introduce a number of measures and a package of initiatives, in particular, aimed at attracting FDI into production:

– establishment of relations between the Ukrainian industrial small and medium-sized enterprises and foreign investors;

– encouraging investment in projects to deepen the processing of raw materials, which will increase the value added of products, create new jobs, will contribute to the growth of industrial production in the regions and its product diversification;

– analysis of existing industrial resources, production, innovation and labor potential of each region and the development of strategies for regional industrial development based on the methodology of smart specialization, etc.

At the same time, it should be emphasized that the effectiveness of system-wide measures and their impact on the development of specific enterprises is largely determined by the specifics of the industry environment and its readiness for transformations. Therefore, the actual stage of research is the analysis of sectoral aspects of industrial investment in the context of the objectives of Industry 4.0.

2. The object of research and its technological audit

The object of research is the investment process of modernization of chemical production.

Chemical production has certain features of technical and technological support, which significantly affect its economy and organization:

– complex continuous technological schemes;

– various types of equipment;

– high fund and energy intensity of production processes;

– significant costs for infrastructure facilities;

– environmental, fire and explosion hazards.

The structure of the Ukrainian chemical complex is dominated by large-scale production of basic chemicals. But they are characterized by significant physical and moral deterioration of technological equipment, and in modern conditions they lose their competitive potential.

Investments for large-scale renewal and modernization of industry production are constrained by a number of systemic reasons (high capital intensity, a long investment cycle, unprofitability or low profitability of many industries), as well as certain destructive situational factors.

At the same time, the ideas of the fourth industrial revolution, or Industry 4.0, are now rapidly spreading around the world, revealing the prospects for industrial development based on the use of cyber-physical systems. Specialists discuss the characteristics of the digital development of the chemical industry and new opportunities related to the Internet of Things [3, 4]. Chemicals 4.0 is formed [5–7] – the industry-wide concept of smart modernization of chemical production.

The restructuring of the Ukrainian chemical industry on the principles of Chemicals 4.0 has many diverse problems. One of the most problematic issues is the investment support of modernization processes.

3. The aim and objectives of research

The aim of research is studying the processes of investing the modernization of chemical production and the definition of approaches to their transformation in the conditions of Industry 4.0.

To achieve the goal of the research the following tasks are defined:

1. To analyze the modern foreign practice of investing innovative development of chemical production.

2. To explore the trends and problems of investment support of the modernization of chemical production in Ukraine.

3. To identify promising approaches to the revitalization of investment activities in the industry in the context of Industry 4.0 formation.

4. Research of existing solutions of the problem

The research of theoretical and applied aspects of investment support of industrial development is devoted to the work of many scientists. In these works, the influence of the quality of forecasting future investment returns on corporate investment decisions was investigated [8]. And also analyzed the model of financing the real sector of the economy and built a financial and economic mechanism to ensure the investment activity of enterprises [9]. The paper [10] explores the relationship between foreign direct investment and the productivity of host country domestic firms. According to the study, the authors separate out productivity gains along the supply chain (obtained through direct transfers of knowledge/technology between linked firms) from productivity effects through indirect investment spillovers.

Special attention is now paid to the issues of financial and investment support of neo-industrial development and digital business transformations. The strategic aspects of investing processes in Industry 4.0 are covered in the work [11]. The influence of digitalization and digital technologies on investment policy and international investment is considered in [12]. The authors believe that the emergence of hybrid business models (related to the integration of digital data and technologies in operations and business models of non-digital enterprises) may lead to the emergence of a new chapter in the globalization of investment. But a restraining factor for cross-border investment decisions can be the unresolved problems of national security and privacy.

The work [13] defines the role of the state in the institutional transformations of the investment component of digital development, in particular, its regulatory, coordinating and stimulating functions. The need for neo-industrial development of Ukraine and the implementation of an active state policy on the investment support of the modernization processes is also noted in [14]. The author's theses on promising forms of investment in industry based on the strengthening of the capacity of centralized and local sources of financing in the context of financial decentralization are worthy of attention. However, scientific and applied issues of expanding budget investment, neo-industrial development require additional study.

The work [15] presents the results of long-term statistical studies the influence of tech investments, ICT and

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financial factors on global manufacturing and service industry performance. Low-tech industries rely on loans and tech investments. As they move to transition industries, tech investments are more important. Once they become highly technologically advanced, bank lending policies become more important.

The specifics of investing in the chemical industry and its individual aspects are outlined in a number of papers. Thus, the results of a study of the R&D investment features, implementing European chemical companies, are given in [16]. A comparative analysis of the investment policy of public and private producers of chemicals is presented in [17]. The treatment of the issues of evaluating the effectiveness of investments in chemical industry enterprises is the subject of [18, 19].

PricewaterhouseCoopers present the results of a global survey of managers of large chemical companies regarding the current status and plans for investing in the digitalization of industry production [20]. Generalized research results show that chemical companies plan to invest in digital technology up to 5 % of their annual income over the next five years. The expected benefits are annual revenue growth of 3.1 % and cost reduction of 4.2 %.

The conducted scientific research shows that the modern economic literature covers various aspects of the investment support of industrial modernization processes, including in the context of Industry 4.0 processes. There are certain developments regarding the sectoral features of the chemical industry.

At the same time, the implementation of the developed approaches in developing countries requires additional research. A review of the literature indicates that individual work, for example, is devoted to the problems of industrial investment in the Ukrainian chemical industry [21].

In [22], on the basis of statistical analysis of the performance factors of the leading chemical companies of the world, it was shown that capital costs are the most significant factor in the growth of chemical production. However, not only investment volumes are important, but also their directions. Therefore, the above trends of intellectualization and digitalization of production should be the basis for rethinking the development policy of the chemical industry in Ukraine and ways to improve its investment support.

5. Methods of research

During the execution of the work the following scientific research methods are applied:

– methods of analysis and synthesis – in the study of modern features of the development of chemical production and the processes of its investment, the impact of Industry 4.0 technologies on the development of the industry;
– comparison method – when assessing the specific capital costs and R&D costs of the chemical industry in the world;
– structural analysis method – to identify differences in the dynamics of indicators for the product segments of chemical production;
– graphic method – for visual representation of the dynamics of financial and investment processes in the chemical industry;
– method of generalization – when drawing conclusions on the key problems of innovative investment in chemical production and ways to solve them.

6. Research results

In the study of foreign investment practice providing innovative modernization of chemical production, the data of the Global Top 50 Chemical Companies 2017 rating [23] and the corporate reporting of two chemical companies, the German BASF and the Norwegian Yara International, were processed. Due to the specifics of production processes, technical support and the influence of market factors on the activities of petrochemical companies, the latter were excluded from the analysis (Table 1).

Table 1

Capital investment and expenditure on research and development of large chemical companies in the world

Company name, country, activity	Chemical sales, million USD	Capital spending, million USD	Capital investment in sales, %	R&D spending, million USD	R&D spending to sales, %
BASF, Germany, diversified	69196	3816	5.5	2082	3.0
DowDuPont, USA, diversified	62484	3570	5.7	2110	3.4
LG Chem, South Korea, diversified	23217	1537	6.6	771	3.3
Air Liquide, France, industrial gases	22618	2323	10.3	330	1.5
DuPont, USA, diversified	17281	687	4.0	1064	6.2
Linde, Germany, industrial gases	16938	1980	11.7	83	0.5
Akzo Nobel, Netherlands, diversified	16471	693	4.2	411	2.5
Evonik Industries, Germany, diversified	16295	1176	7.2	518	3.2
Covestro, Germany, diversified	15977	586	3.7	310	1.9
PPG Industries, USA, diversified	14750	360	2.4	453	3.1
Shin-Etsu Chemical, Japan, diversified	12859	1573	12.2	462	3.6
Solvay, Belgium, specialty chemicals	12308	799	6.5	328	2.7
Mitsui Chemicals, Japan, diversified	11852	710	6.0	298	2.5
Praxair, USA, industrial gases	11437	1311	11.5	93	0.8
Yara, Norway, agrochemicals	11347	1335	11.8	45	0.4
DSM, Netherlands, specialty chemicals	9755	508	5.2	378	3.9
Air Products & Chemicals, USA, industrial gases	8188	1040	12.7	58	0.7
DIC, Japan, specialty chemicals	7043	283	4.0	111	1.6
Clariant, Switzerland, specialty chemicals	6480	252	3.9	215	3.3

Note: developed on the basis of data [23]

The data of Table 1 indicate that among the top companies in the world in the production of chemicals in terms of quantity and volume indicators diversified companies prevail. They are also leaders (together with manufacturers of special chemicals) by unit costs for research and development (2–6 %). At the same time, the share of capital expenditures in the sales of industrial gas and agrochemical companies (more than 10 %), with some

exceptions, markedly exceeds the similar indicators of diversified companies. These data reflect different development strategies and investment priorities in different segments depending on their place in the global value chain of the chemical industry.

Differentiated by segments of chemical production, there is a return on invested capital. Thus, according to experts of McKinsey & Company, the median return on invested capital (before tax) in the production of special chemicals is more than 16 %, in diversified companies – about 12 %, in the production of basic chemistry – 11 %. These values exceed the corresponding average for the global economy [24].

The development of large-scale basic chemical production (early stages of chains) is based on access to cheap resources, highly efficient technologies and favorable logistic flows. Therefore, investments in these segments are aimed primarily at building new plants, expanding and modernizing existing facilities, creating infrastructure facilities, and acquiring production assets, transportation and distribution systems.

At the same time, companies in developed countries are gradually losing competitiveness in the markets for large-tonnage products due to high prices for raw materials. Therefore, they are forced to shift the focus of attention to the final stages of global value chains and diversify portfolios of investments in the direction of high technologies of deep processing and production of high-tech low-tonnage products.

This trend can be traced by comparing the structure of sales, investments and R&D expenditures by product segments of BASF in 2017 (Fig. 1).

The study of modern features and results of the leaders of the world chemical business shows that the technologies of Industry 4.0 are becoming an integral part of their innovative investment strategies. For example, BASF already has a wide portfolio of innovative materials, system solutions, components and services for 3D printing. In 2017, a subsidiary of BASF 3D Printing Solutions GmbH was founded to purposefully expand this business.

In addition, the Dutch manufacturer of the threads Innofil3D B.V. was acquired, which made it possible to organize the production of long thin plastic fibers for 3D printing.

Yara International, a leading player in the global mineral fertilizer market, in 2017 continued to develop its platform for Circular Economy and the SINTEF Innovation Lab. With SINTEF, Yara aims to explore ways to revolutionize fertilizer production and develop technologies that allow for more environmentally friendly, cheaper and smarter processes, as well as development of sensor technologies.

As for the Ukrainian chemical industry, it has recently been in a deep crisis caused by a combination of destructive economic and sociopolitical factors. Calculated according to the State Statistics Service of Ukraine [26], the cumulative index of industrial products in the chemical industry in 2013–2017 has made 0.703.

The financial performance showed a catastrophic state of basic chemical production: at the end of 2014, accumulated losses amounted to almost 3 billion USD and the annual unprofitability of operating activities reached 23.5 % (Fig. 2).

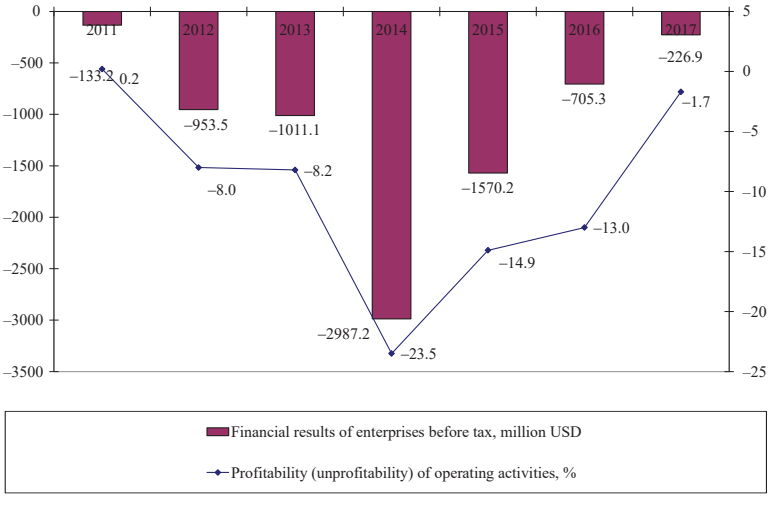

Fig. 2. Dynamics of financial performance of chemical production in Ukraine (developed on the basis of data [26, 27])

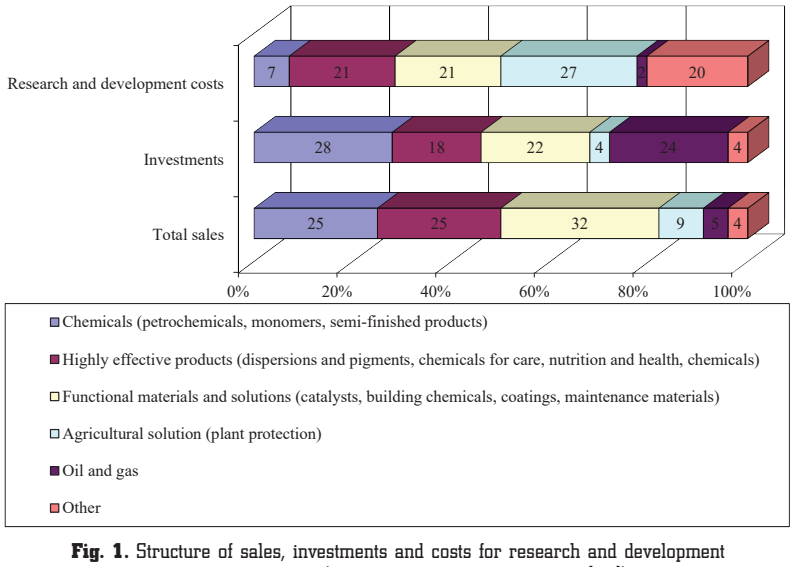

Fig. 1. Structure of sales, investments and costs for research and development of BASF company (developed on the basis of data [25])

Due to the deterioration of the indicators of production and commercial activity and the lack of revenues, investment activity in 35 % of the enterprises of the industry decreased (Fig. 3, 4). In addition, most of the investment went to the restoration of worn-out equipment, so this scale of investment was insufficient to meet the challenges of innovative modernization of the industry.

In the second half of 2017, recovery growth began in the sector. At the end of last year, the volume of chemical production increased by 18.4 %, including in the basic chemistry – by 26.3 %. In January-October 2018, the industrial production index in the sector was 124.4 %, including 147.2 % for basic chemicals. The high rates of this dynamic are explained by the restoration of the work of several structure-forming

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enterprises after long downtimes, as well as the effect of a low statistical base. But the experience of the previous stages of development of the chemical industry of Ukraine indicates a limited and temporary upward trend based on situational factors. Therefore, the impetus and results of the current growth should be used for a radical transformation of the industry production model.

The data in Fig. 3 show that from 2017 there is a gradual recovery of capital investments in the Ukrainian chemical industry. But their share in sales (4.5 %) has not yet reached the pre-crisis level (6.1 %) and is in the lower range of the corresponding figure for a group of world leaders in the industry.

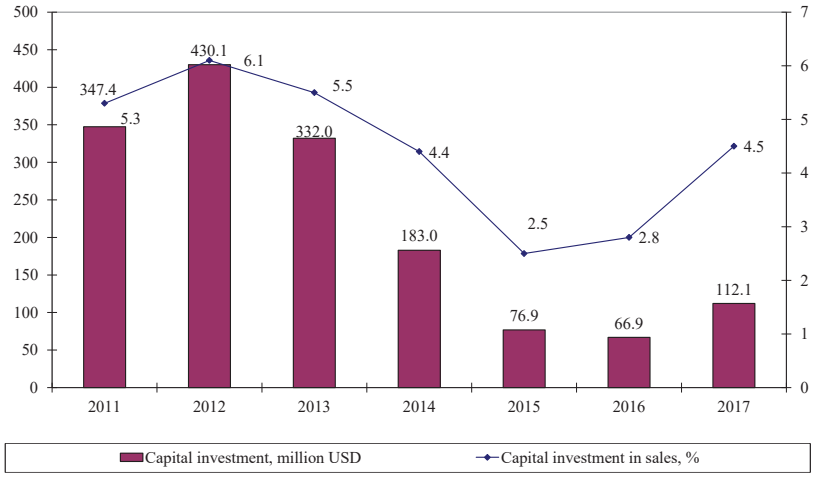

Fig. 3. Dynamics of capital investments in the chemical production of Ukraine (developed on the basis of data [26, 27])

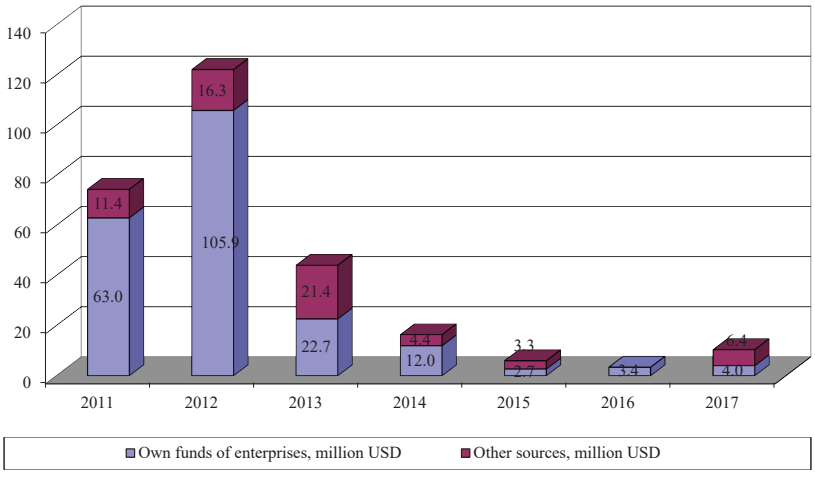

Fig. 4. Dynamics of financing innovation activities in the chemical industry of Ukraine (developed on the basis of data [26, 27])

Noticeably worse is the level of specific innovation costs in the chemical industry of Ukraine: in 2016 it fell to 0.14 %, and by the end of last year it grew only to 0.4 %. The achievable guideline for recovery here should be the level of 2012 – 1.7 %.

The reduction in specific innovation costs in 2016 was due to a significant (11 times compared to 2012) falling of industry investment in innovation. Following them, the industry indicators of innovation activity and performance have plummeted.

In 2017, innovative investments in chemical production somewhat revived, but this did not lead to positive changes in performance indicators. However, it should be noted a significant increase in the cost of domestic R&D, which may indicate the spread in the field of innovative thinking and the formation of appropriate business models.

The limited sources of financing are important problematic issues for innovative investment. Fig. 4 indicates that external sources of investment are not systemic in nature, but their significant contribution to the financing of innovations in the pre-crisis period indicates investment prospects for the sector.

Foreign investment can be a powerful driver for the development of the industry on innovative principles. But the dynamics of foreign investment largely depends on macroeconomic, institutional and non-economic factors.

The study of the dynamics of foreign investment in chemical production showed that their slow growth until 2013 replaced by the active outflow in subsequent years. If in 2013 foreign investment in the chemical industry accounted for 2.2 % of the total foreign investment in the economy of Ukraine, in 2017 this share decreased to 1.7 %. This value is calculated on the basis of data [26].

Own funds of enterprises are also objectively limited by the source of investment, since Ukrainian chemical production has so far failed to achieve profitability of the activity (Fig. 2). However, if analyzing the financial results before the taxation of enterprises depending on their size, it becomes clear that the main contribution to the negative industry financial result is made by large enterprises. At the same time, according to the State Statistics Service of Ukraine [26], 79.2 % of medium-sized and 72.1 % of small enterprises received profits in 2017.

It is worth noting here that previously, the focus in developing the region's industrial and investment policy was on the resource efficiency of large enterprises of basic chemistry, which produced two thirds of the total industry product. Now the Ukrainian basic chemical production is gradually losing its competitive potential. The current performance of individual enterprises depends mainly on institutional and other non-economic factors [28].

Basic chemistry enterprises had good investment opportunities for radical modernization in the mid-2000s. Their investment programs contained many measures for technical re-equipment, optimization of production capacity, energy saving, diversification of production, development of new types of products. But the implemented projects had an improving character within the existing technical and technological level of production, which provided only temporary support for its competitiveness.

Today, the sector is dominated by «short», point investments focused on the production of liquid products of traditional demand [21]. Investors are not interested in the modernization of outdated Ukrainian basic chemical plants through a set of diverse risks and the best alternatives available.

At the same time, separate segments and activities related to the manufacture of differentiated products for consumer markets are gradually developing in Ukraine. These are the production of complex agrochemical products, paints and varnishes, flame retardants, household chemicals, cosmetics, water purification agents, materials for modern diagnostic methods, etc. These segments are distinguished by the significant participation of foreign capital, the attraction of advanced foreign technologies and readiness for further innovation development.

The active development of these industries should be considered in the context of neo-industrial models, now rapidly spreading in the industrialized countries. Neo-industrialization of chemical production provides, among other things, the creation of high-tech environmentally friendly low-tonnage production in the segments of the special and «fine» chemistry (the final stages of the value chains) based on innovative technologies.

In investment terms, such a transformation of strategic benchmarks in the development of chemical production means the possibility of a parallel-sequential investment method, when the creation of high-value-added industries is financed by funds generated by the previous stages. This is the opportunity that now exists in the Ukrainian sector of basic chemistry. This chance should be used to preserve and extend value chains that are traditional for the Ukrainian chemical industry.

A weighty source of foreign investment in digitalization and the development of chemical production on a smart basis can be investment in consumer industries. The fact is that modern chemical production is a member of various value chains, which causes its great intersectoral importance. McKinsey & Company specialists write: «Last, we must keep in mind that the chemical industry has an intrinsically sound business model: its products enable the «world of things». Without some support from the chemical industry, hardly any of what we touch, of the buildings we live in, the food we eat, and the healthcare we receive could exist. The industry as a whole is therefore positioned to profit from a wide range of trends, from sustainability to e-mobility, from commodity demand surges to major changes in consumer behaviour» [29].

But in Industry 4.0, the role of chemical manufacturing is increasing, as it is a key supplier of advanced materials for digital and smart technologies. For example, [30]:

– for mobile and smart devices, components from modern chemical materials are necessary substrate, backplane, transparent conductor, barrier films and photoresists;
– for high-speed Internet – chlorosilane for ultrapure glass;
– for more efficient and smaller integrated circuits – dielectrics, colloidal silica, photoresists, yield enhancers and edge-bead removers.

Another chemical production partner in the application of smart solutions is agriculture. The concept of «precision farming» involves the use of chemicals with precise means to increase yields. This approach requires a trusting, transparent relationship between farmers, manufacturers and suppliers of agrochemicals, developers and equipment manufacturers, traders. All partners receive their benefits through access to optimal solutions generated by technical platforms based on processing large amounts of data.

The agricultural sector is now one of the locomotives of the Ukrainian economy. It generates a significant portion of gross domestic product and export earnings. The introduction of new technical solutions, in particular, digital, is a promising direction for increasing the efficiency of agricultural production. So, the Ukrainian agrarian sector also needs investment opportunities for the development of various inter-sectoral innovation ecosystems, including cooperation with chemical production for the implementation of the concept of «precision farming».

In the management of sectoral development processes on a neo-industrial basis, an institutional aspect is important. According to the State Statistics of Ukraine [26], the number of major chemical producers decreased from 18 in 2011 to 8 in 2017, medium-sized enterprises – from 193 to 161, and small enterprises – increased from 1504 to 2075. In addition, for many years the basis of the business strategies of large enterprises is not innovative investment drivers, but situational non-economic advantages. Analysis of the reporting of leading enterprises shows that in recent years, technological refinements have not been carried out by them.

At the same time, small and medium-sized enterprises (SMEs) are developing in the region, which, in certain technological areas, has a competitive portfolio of innovative developments, creates new production facilities and is looking for opportunities to integrate into global value chains. So, the modern foreign practice of neo-industrial development and the activation of SMEs in the Ukrainian chemical sector indicate a shift in the focus of investment in the direction of knowledge-intensive low-tonnage production with high added value.

However, investment issues by SMEs in Industry 4.0 technology are more complex. Without breaking the whole range of problems of investment activity of small and medium-sized enterprises, let's focus on two aspects.

The common digital tools and smart solutions that the ICT sector offers must be adapted to the specific industry conditions. On the other hand, the request for relatively inexpensive business solutions in the development of smart technologies can be satisfied only if there is enough demand from the subjects of the industry and cheaper unit costs for individual projects.

Another problem is considerable uncertainty and high innovation risks of such projects. Investors are forced to make investment decisions in conditions of high information asymmetry and require certain signals to reduce it.

In fact, both problems affect the improvement of market communication between the industrial and ICT sectors. To solve them, it is necessary to take advantage of foreign experience supporting innovative initiatives. For example, the promotion of the organization of industry demonstration centers to highlight the best practices or test sites for the implementation of pilot innovation projects. Given the shortage of financial resources for investing such an infrastructure of Industry 4.0, one should actively use the experience and resources of European institutions.

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7. SWOT analysis of research results

Strengths. The proposed approaches to the revitalization of industry investment in the context of Industry 4.0 take into account the international experience of the neo-industrial development of chemical production, the current problems of investment support for the modernization of the Ukrainian chemical industry and the special role of chemical production in the processes of the fourth industrial revolution. They allow to overcome the existing limited financial resources and mobilize investments to launch smart modernization of chemical production.

Weaknesses. The proposals envisage the attraction of organizational and communication resources of the business community for the use of sectoral and inter-sectoral synergies, but only large chemical enterprises have positive experience of collective initiatives.

Opportunities. Given the high intersectoral importance of chemical production as a supplier of smart materials and technologies, smart modernization of the chemical industry can become a driver for Industry 4.0 processes in other sectors of the economy.

Threats. In Ukraine, there is a complex of macroeconomic and socio-political risks. If they are implemented, the investment climate will deteriorate. This will lead to further reductions in industrial investment and inhibition of Industry 4.0 processes.

8. Conclusions

1. The modern foreign practice of investing innovative development of chemical production is analyzed. It is revealed that the development strategies of enterprises and their innovation and investment priorities depend on the role of the segment in the global value chain of the chemical industry. The average level of investment in research and development among industry leaders is 2–3 % of sales, capital assets – 8–10 %. Due to the loss of competitive positions in the markets for large-tonnage products, companies in developed countries are shifting attention to the final stages of value chains, that is, they diversify their investment portfolios in the direction of high technologies for deep processing and the production of high-tech small-scale products.

2. The tendencies and problems of investment support for the modernization of chemical production in Ukraine are investigated. It is shown that as a result of a deep systemic crisis of industry production, there has been a significant drop in capital and innovative investments. The traditional business model of the Ukrainian basic chemical production is gradually losing its resource and technological basis, but there are not enough investments within the industry for its radical modernization. For external investors, certain segments of the chemical industry that produce liquid small-tonnage consumer goods are of particular interest. The development of these industries can be viewed as non-systemic examples of the neo-industrial sector upgrades.

3. The promising approaches to the revitalization of investment in the chemical industry in the context of the formation of the Industry 4.0 are identified. They are based on the special role of chemical production as a supplier of smart materials and technologies, making it a necessary component of any innovation ecosystem. So, external investments for the smart modernization of the industry should be sought among the chemical industries.

Based on the existing institutional structure of the chemical industry of Ukraine, in the development of sectoral processes of Industry 4.0, the rate should be placed on SMEs. But, given the lack of technological preparedness and investment support of such structures, they need specialized support and program funding.

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