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## TRANSFORMATION OF THE METALLURGICAL INDUSTRY OF UKRAINE FROM THE CONCEPT “INDUSTRY 4.0” TO CAPITALISM OF STAKEHOLDER

**Purpose.** To determine the level of development of the metallurgical industry of Ukraine in accordance with global trends of its transformation from the concept of “Industry 4.0” to the capitalism of stakeholders.

**Methodology.** In order to achieve the purpose of the study a system of general and special methods was used: generalization – during a comparative analysis of competitive advantages of individual countries implementing the Concept “Industry 4.0”, to compare the level of industrial safety of the metallurgical industry in Ukraine and global indicators of economic activity; statistical and econometric ones – methods of analysis of dynamic series (for analysis of trends in the main indicators of export-oriented industries of Ukraine, finding indicators of descriptive statistics), methods of standardization of indicators and integrated evaluation (to assess the industrial safety of the metallurgical industry of Ukraine); methods of correlation analysis (to determine the impact of export-oriented industries of Ukraine on GDP, the formation of a system of indicators of the greatest impact on industrial safety in the metallurgical industry). Methods of graphic visualization of integrated assessment of production safety of the metallurgical industry of Ukraine are used.

**Findings.** It is shown that for the development of the metallurgical industry of Ukraine the concept of “Industry 4.0” should be considered from the standpoint of the concept of “Capitalism of stakeholders”. The dynamics of crude steel production for 2011–2020 is analyzed, the analysis of trends of which showed the growth of “stakeholder capitalism” in the countries. After comparing and analyzing the indicators of export-oriented industries in Ukraine, it was determined that the metallurgical industry has relative stability against the background of global growth in funding and the amount of basic research in developing components of the concept of “stakeholder capitalism”. A system of indicators for assessing the production safety of the metallurgical industry of Ukraine has been formed, taking into account the data of countries in which the features of stakeholder capitalism have emerged. The obtained results of the analysis of the integrated indicator of production safety of the metallurgical industry of Ukraine with world indicators of stable development of this industry, allow providing operational information on the effectiveness of the metallurgical industry of Ukraine as one of the leading components of Ukrainian economic foresight.

**Originality.** The authors offer a scientific approach to the transformation of the metallurgical industry of Ukraine in accordance with global trends in the industry and the priorities identified by advanced countries. It is based on improving the instrumental apparatus for assessing the effectiveness of the transformation of the metallurgical industry of Ukraine from the concept of “Industry 4.0” to the concept of “Capitalism of stakeholders” and scientific understanding of the level of industrial safety of the metallurgical industry in Ukraine and global economic indicators.

**Practical value.** The obtained results create a basis for developing approaches to assessing the production safety of the metallurgical industry to ensure the economic security of the industry as a whole.

**Keywords:** *industrial safety, metallurgy, stakeholder, indicators, integrated assessment, societal paradox*

**Introduction.** The concept of “capitalism of stakeholders”, although being a scientific understanding of the market economy in 2021, is based on the branches of the real sector of the economy as in the classical interpretation. In turn, this concept due to the previous one (“Industry 4.0”) has already outlined the components: adaptive management (in the aspect of the structure of adaptive platforms and architectures, including software platforms, modular hardware, multifunctional information systems, etc.), IT innovations (I<sub>2</sub>O, in the aspect of data mining, high-performance calculations, and others), microsystem technologies (micromechanical systems, the architecture of integrated chips and algorithms for distributed data storage, etc.), strategic technologies (information networks, resistance to cyber-attacks, etc.), tactical technologies (modern high-precision weapons systems, unmanned vehicles based on air, space, land and sea platforms, etc.), and so on. In addition, any industry in the 21<sup>st</sup> century is not circular. For the formation of reserves, one industry (as it was before the 21<sup>st</sup> century) uses the goods from another branch of the econ-

omy. At the same time, in the 21<sup>st</sup> century, coordination of the work of industry and research centers for the strategic development of state economies remains a priority of ministries and departments of government machines, which bureaucratize the introduction of any innovations. However, recently it has become increasingly remarkable that there is a race of advanced economies of the world in the trends of technological production. Technological innovations are funded by the donor or corporate funds to minimize losses. Technologies for manufacturing goods are changing both in metallurgy and related industries (mining and chemical). However, structurally, all countries involved in the metallurgical industry are conventionally divided into economies with leading technologies (and high positive value of goods) and economies with outdated technologies (and low positive value of goods). The concept of “capitalism of stakeholders” tends to develop a circular economy or return to a closed-cycle economy.

The scheme of the production complex of the Ukrainian metallurgical industry used in implementing the Industry 4.0 concept will only echo the generation of the problems in which it finds itself. According to the results of the implementation of the Industry 4.0 concept in the world, steel production takes

less energy, fewer materials, and other resources; through the development of the chemical industry and with the help of extracted resources, it becomes more potent and more volatile at the same time; it can be reused; it is subject to restoration; it is characterized by recycling. Therefore, it is appropriate to develop the metallurgical industry in Ukraine with modern global trends in the concept of Industry 4.0 in the concept of “capitalism of stakeholders”. In the capitalism of stakeholders, the goods of the metallurgical industry play a leading role in developing the circular economy by ensuring optimization of the weight of the product (without significantly changing the physical shape of the object or material) and the resources that are spent on its manufacture. In the sustainable future, new economic models will maximize the value of raw materials by encouraging practices such as reuse and recycling. The weight of many steel structures will be reduced, losses will be minimized, and the high level of steel processing will increase even more, which will lead to an increase in the production of new steel products and the infrastructure for their use.

Accordingly, Ukraine, recognizing the current trend, should be in the trend of the global revitalization of the industrial complex, for a start, in the context of the metallurgical industry.

**Literature review. Unsolved aspects of the problem.** The largest number of studies deals with the current role of the metallurgical complex of countries in global steel production and export (for example [1, 2]) and the features of the functioning of the concept of Industry 4.0 in various areas (for example [3]). Scientists and practitioners have recognized the following decisive factors for the success of the metallurgical industry:

- updated methods for steel processing and optimization of technological costs by increasing our sources of financing in the context of digital optimization of operations [4, 5];

- increasing labor productivity, reducing the resource and energy intensity of production, eliminating gaps in innovation and investment spheres of activity [6].

Analytical projects [7] and scientific works [8] are devoted to the critical dependence of the industry on the demand in foreign markets, which is based on the export orientation of raw materials.

However, the problems of functioning of the metallurgical industry and Ukraine have not been solved yet. Entirely new socio-political and economic prerequisites for the functioning of the real sector in the world's market economies are being formed. Thus, in the Ukrainian economic scientific and analytical literature, there are more and more arguments in favor of building a circular economy.

As stated in Wordsteel [9], steel is a permanent material in the circular economy. Trends in the development of global ferrous metallurgy, systematized by A. Romanova, et al. [10], allowed the authors to formulate the latest technological and institutional trends in the development of the industry in the Industry 4.0 concept. They identified the technological and informational capabilities of metallurgical production in Russia, as one of the main competitors of Ukraine, against the background of low labor productivity, sorting efficiency, etc., by evaluating its digitalization based on a set of reasonable indicators. The founder and president of the World Economic Forum in Davos, Klaus Schwab, emphasizes that to achieve the goals set out in the Paris Climate Agreement and the UN Order for Sustainable Development, the best model for the development of the world is the model of “capitalism of stakeholders” – a model that “positions private corporations as acting in the public interest, solving social and environmental problems of our time”. Accordingly, since 2021, K. Schwab has introduced the concept of “capitalism of stakeholders” in scientific and research circles as a logical continuation of the theory of capital [11]. Now it identifies completely new factors of production that form an additional product; conceptualizes an entirely new structure of values: the digital footprint, raw materials for

artificial intelligence, and emotions in the digital economy of capitalism stakeholders. In this context, the importance and role of the real economy sector, in general, and metallurgy, in particular, during the formation of national capital changes somewhat, as do the factors that determine the economic effect. It should be noted that the transition from the Industry 4.0 concept to the capitalism of stakeholders occurs during the quarantine measures of 2019–2021. Now it is no longer enough to use the two most common options for maximizing corporate finances: cost minimization-profit maximization; adaptive management, innovations in information, microsystems, strategic and tactical technologies determine the future vector of metallurgy development in the concept of stakeholders. Moreover, for each group of stakeholders, these components will have their own (individual) content array.

Bykova-Fedorchuk N., et al. have identified groups of stakeholders in domestic metallurgical production [12]. Most of them (11 business entities of the metallurgical industry) are registered in Ukraine, two entities – in Austria, one entity in the UK, and one in Luxembourg. This structure of the metallurgical industry encourages investment protectionism, which negatively affects the technological modernization of production processes and goods in the industry. This makes the industry resource-dependent on classical energy products – oil and gas coming from the Russian Federation, and low-competitive according to international quality standards, which China actively uses with more developed technological chains of metallurgical processing.

The article proves that the success of the export policy, along with improving the quality of the technological process and goods of the metallurgical industry, depends on China and Russia. The results of the production activity of these countries are also recommended for consideration in Guidelines for calculating the level of economic security of Ukraine (section of industrial safety) [13]. Accordingly, the comparative characteristics of the readiness of the world's leading economies (the United States and Germany) to move from the Industry 4.0 concept to the capitalism of stakeholders are carried out taking into account these countries.

**Purpose.** Determination of the level of development of the metallurgical industry of Ukraine following global trends in the transformation of state and global economies of this sector from the Industry 4.0 concept to the capitalism of stakeholders.

**Results.** The main concepts of the conditions for the implementation of the Fourth Industrial Revolution in the Industry 4.0 concept were generated by the leading countries of the world, whose economy is based on the dominance of the processes of mastering new energy resources in the world – coal, oil, gas, non-traditional sources (Table 1).

The results of the Industry 4.0 concept implementation were the creation of cyber-physical production, the use of energy from renewable sources, and the creation (in 2009) of blockchain technology and the first decentralized cryptocurrencies. First of all, cyber-physical production has significantly affected the development of the real sector in the world. If the second industrial revolution, the Bessemer method of melting steel and the invention of the conveyor were invented, in the third – there was automation and reduction of production processes at the expense of renewable energy sources, the invention of their alternatives. The fourth industrial revolution brought cyber-physical production based on the components of Big DATA, cloud environment and technologies, automated robots of cyber systems working in the “Industrial Internet of Things”, adaptive production and three-dimensional printing, as well as virtual modeling and reality allowed forming the empirical basis for the beginning capitalism of stakeholders. It should be noted that, from a financial point of view, only China has completed the implementation of the Industry 4.0 concept with a new financial instrument that has a legislative basis, was generated by the country's government, and has no analogs in the world yet. In 2021, its work was launched, and

Comparative table of competitive advantages of countries in the implementation of the Industry 4.0 concept

Comparative category	Germany	USA	China	Russia
Key program (name)	Industry 4.0	Industrial Internet Consortium	China Manufacturing 2025	TechNet technology track of the National Technology Initiative (1); Digital economy (2)
Grounds	Interoperability of virtualization. Decentralization and real-time operation	Digitalization and integration of vertical and horizontal chains, products and services offered, business models and consumer accessibility, digital trust	Compliance of economic development with global trends	Compliance of economic development with global trends
Stakeholders	Government	Multinational corporations	Government	Government
Key organizers	Government, scientists, business	Business, scientists, government	Government, scientists, business	Politicians
Development stage	4 <sup>th</sup> revolution	3 <sup>rd</sup> revolution	3 <sup>rd</sup> and 4 <sup>th</sup> revolutions	3 <sup>rd</sup> and 4 <sup>th</sup> revolutions
Platform	Government industrial policy	Non-profit consortium with open participation	Government industrial policy	Government industrial and social policy
Focus	Industry (introduction of digital compatibility)	Manufacturing, energy, medicine, transport, agriculture, utilities	Automation and digitalization of production processes	Engineering processes, production management technology (1); digitalization of production and social services (2)
Geography	Germany and German companies	Global market	Priority to Chinese companies	Government, priority to Russian companies
Active companies	Small and medium-sized enterprises	All enterprises	All enterprises	High-tech enterprises
Optimization object	Production	Assets, increasing their profitability, focusing on overall financial return	Production	Improving production efficiency
Year of completion of the strategy	2025	n/a	2025	2035 (1); 2025 (2)
Budget	\$ 900 billion	n/a	n/a	100 million rubles (2)
New financial instrument [14]	–	–	Cryptoyuan	–
New technology [14]	Under the patronage of the World Economic Forum – blockchain studios and blockchain startups of the world's largest miners Glencore, CMOG, and Eurasian Resources Group for tracking carbon and metal emissions (2019), improving cobalt tracking with reduced carbon emissions (the Democratic Republic of the Congo, 2022, under implementation), development of new generations of steel			

incentives for use were established for agents of the economy of other countries, as well as the restrictions on the social rating of an individual who holds this financial instrument. Being technologically and financially innovators based on the implementation of the leading Chinese production program, in 2025, China will be able to dominate the market offers of at least the metallurgical industry.

According to the above, the following arguments were used to justify the election of these countries:

1) of the top 20 steel producers, only Egypt, China, and the United States show better dynamics than Ukraine. However, if China succeeds at the expense of powerful programs aimed at stimulating the domestic market, and the United States and Egypt – at the expense of protectionism, then Ukraine – solely due to competition in international markets. It should be noted that this growth was mainly due to semi-finished products. Such an unfavorable situation for Ukraine occurs due to trade restrictions on the international raw materials market, the use of which in the country's metallurgy is growing [15];

2) in 2021, China's incentive programs are expected to decline and steel exports to rise. However, the Chinese government plans to reduce steel production and encourage the im-

port of semi-finished products, which, in a tactical sense, is quite acceptable for Ukraine [16];

3) Guidelines for calculating Ukraine's economic security level determine the feasibility of calculating industrial safety based on data from Germany, Italy, Spain, China, Russia, and Poland [13]. At the same time, the German economy is recognized as the flagship in the economy of the European Union.

At the moment, the capitalism of stakeholders in the world continues to develop new generations of steel that allow manufacturers and builders to implement strong and lightweight structures. However, these developments are commercial and represent the subject of competition "wars". Technological improvements in metallurgical production and an increase in China's share in the global ferrous metal raw material market back in 2020 marked the beginning of a new raw material super cycle (Table 2).

In 2019 (the preparatory year for the raw materials super-cycle) demonstrated a reduction in the production of the metallurgical and mining industry due to stagnation of prices on world steel markets and protectionist measures from other countries, falling prices for base metals on world markets, repair (modernization) of production facilities in metallurgy, high reserves of coal and natural gas against the background of

Total production of Crude Steel, thousand tons [2, 17]

Indicators	Ukraine	Germany	China	Russia	United States
2011	35,332	44,284	701,968	68,852	86,398
2012	32,975	42,661	731,040	70,209	88,695
2013	32,771	42,645	822,000	69,008	86,878
2014	27,170	42,943	822,306	71,461	88,174
2015	22,968	42,676	803,825	70,898	78,845
2016	24,218	42,080	807,609	70,453	78,475
2017	21,417	43,297	870,855	71,491	81,612
2018	21,100	42,435	928,260	72,122	86,607
2019	20,848	39,627	1,001,306	71,575	87,761
2020	20,616	35,658	1,052,999	73,400	72,690
Maximum	35,332	44,284	1,052,999	73,400	88,695
Minimum	20,616	35,658	701,968	68,852	72,690
Mean	25941.5	41830.6	854216.8	70946.9	83613.5
Standard Deviation	5439.03451	2342.1953	105843.7	1314.9972	5134.8284

warm weather conditions, a decrease in demand from mechanical engineering and construction (in metallurgy) and from metallurgy (in mining). The rapid growth of the green economy will have an even greater negative impact on traditional hydrocarbon energy resources, such as oil and coal. As a result, their real prices will decline in the coming decades. This supercycle provoked an increase in prices for most raw materials in early 2021. They especially grew for industrial metals, rolled products, rebar, and fuel. Thus, copper prices soared to the highest level in 10 years. The metal market has switched on Turbo mode: since the beginning of the year, copper has risen in price by 28 %, palladium – by 40 %, aluminum – by 18 %. However, the absolute record belongs to rebar and metal structures. Rebar prices rose by 90–110 % in the 1st quarter of 2021 alone. In comparison, the main banking metals (silver and gold), on the contrary, fell in price.

Along with this, we note that the capitalism of stakeholders implies the emergence of certain societal paradoxes:

- by developing economic relations, stakeholders pose a threat to the political-territorial sovereign organization of public power by appropriating the added product and increasing the financial strength of private entities;

- states strive to become these stakeholders – the start of the supercycle is financed for an extended period by central banks and governments of the world's leading economies to reduce the negative consequences of the pandemic.

The supercycle began when China accounts for more than half of the world's demand for copper, nickel, and iron ore. Having formed a financial basis from US government debt securities, China is developing the national real sector of the economy by "heating up" the global commodity market, on the one hand, and introducing cryptocurrencies, on the other. The consequences of China's state stimulus in the form of "overheated" world markets and over-credited economies, implemented in the international currency exchange system, are leveled by state regulation and rules for servicing cryptocurrencies.

In the economic interpretation of the problem, the authors limited themselves to three paradoxes, but their number may be greater.

The market for the group of ferrous metals, which includes steel and iron ore, and in terms of monetary volume is many times superior to the market for non-ferrous metals, will not receive support from central banks and governments of the world's leading economies. Rather, on the contrary, dirty blast-furnace production will gradually yield its share to the electric

steel-making process, which will reduce the demand for iron ore. In this case, there are certain risks for Ukraine. They have technological implications and financial implications. Until recently, the metallurgical industry of Ukraine was a strategic component of the national economy. However, the current general tendencies of a decline in demand and production of metallurgical products and prices for it, state protectionism in traditional Ukrainian metallurgy export countries, destructive protective actions of the authorities in related industries aggravate the crisis in the economy. Restrictions on imports of sulfuric acid, an increase in rental payments for iron ore mining, and the risks of an increase in electricity tariffs also have a negative impact on the development of the industry. There is not a single national, regional or comprehensive program for the development (transformation) of the metallurgical industry (metallurgical regions) in Ukraine. Therefore, there is a need to conceptualize and monitor the level of production safety of the metallurgical industry of Ukraine; to compare its level with global indicators, analyze the general trend of these indicators.

Comparing the indicators of export-oriented industries of Ukraine (mining, metallurgical, chemical industry) in the total volume of production for 2011–2020 (Fig. 1), the metal-

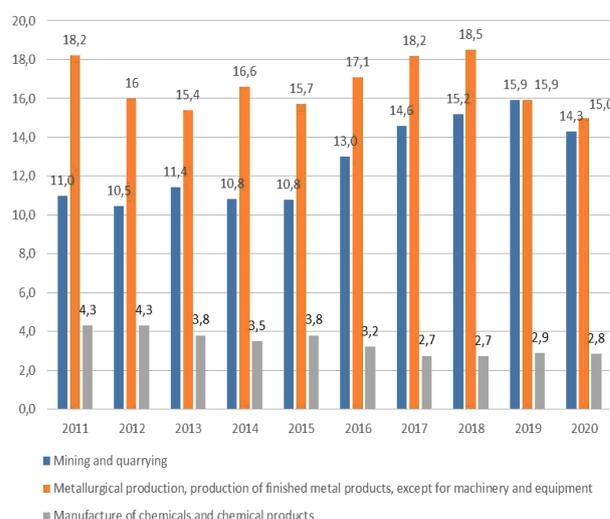


Fig. 1. Structure of the volume of sold industrial products by type 2011–2020, %

lurgical industry has relative stability against the background of global growth in funding and the number of fundamental studies on the concept of “capitalism of stakeholders”.

However, Fig. 2 allows recording a relatively uniform dynamics of Ukraine’s industrial production indices by type of activity, which once again indicates that Ukraine is not ready for an active role in the modern world raw materials market of ferrous metals.

The dynamics of industrial production indices in Ukraine by type of activity in the metallurgical, mining, and chemical industries in 2011–2020 testify to the coincidence of their development rates, except the growth rates of the domestic chemical market. In the chemical industry, due to the resumption of operation of individual chemical enterprises, positive results have been observed since 2015, but the growth dynamics has slowed down since 2017.

After calculating the average for 2011–2020 indices of industrial production and the index of the physical volume of GDP (Fig. 3), and the coefficients of cross-correlation (Table 3), it was determined that metallurgy continues to have a significant impact on the overall performance of the Ukrainian economy (close positive correlation 0.94).

Technologically unable to compete with the goods of the Chinese metallurgical industry, over the years, the high raw material dependence of the Ukrainian economy does not change. About two-thirds of Ukrainian exports are closely linked to commodity markets, primarily ores and metals. At the same time, due to the shortage of its resources and low energy efficiency, at least one-third of Ukrainian imports depend on oil and natural gas prices. All this makes the Ukrainian economy hostage to sharp price fluctuations in the commodity markets. The trade balance and GDP suffer, the hryvnia is weakening, inflation is accelerating, and the population’s real incomes are falling. At the same time, this structure of the economy unexpectedly contributed to Ukraine in the pandemic 2020: according to its results, energy prices significantly lagged behind the prices of ore and metals [19]. As a result, the trade deficit has tripled, and overall, the economy has suffered relatively small losses compared to other developing countries.

2021 also promises a fairly good external economic environment so far: ore and metal prices are still close to multi-year record highs, and oil and gas prices, although growing faster, can only partially reduce the gap.

However, previous years’ experience shows that prices for Ukrainian raw material exports can be very volatile, and rapid ups can be followed by even more rapid falls. The situation with strong export prices and weak prices for imported energy can quickly change to the exact opposite when the inflow of liquidity to financial markets weakens along with the pandemic, and growing mobility and business activity will increase demand for fuel.

In order to analyze the economic security of the metallurgical industry, the level of safety in the production sphere was determined by the method for calculating the integral index. Due to the lack of a universal methodological approach to assessing the level of industrial safety in the metallurgical industry, the selection of indicators that most fully characterize this component of economic security was carried out taking into account the assessments of Ukrainian expert scientists, as well

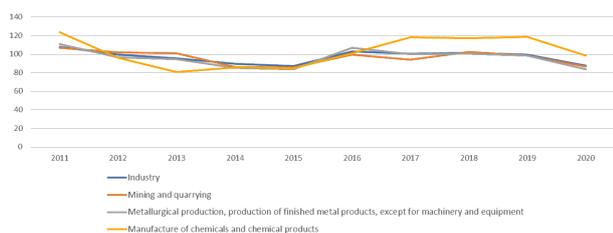


Fig. 2. Dynamics of industrial output indices in Ukraine by type of activity (% compared to the previous year) for 2011–2020

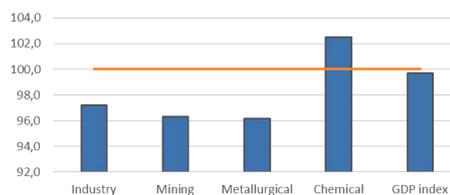


Fig. 3. Average values of industrial production indices for 2011–2020 and the index of physical volume of Ukraine’s GDP, % to the previous year

Table 3

The matrix of correlation coefficients between the indices of industrial production of the corresponding industry and the index of the physical volume of GDP, % to the previous year

Types of industry	Mining	Metallurgical	Chemical	GDP
Mining	1			
Metallurgical	0.85	1		
Chemical	0.55	0.78	1	
GDP	0.89	<b>0.94</b>	0.77	1

as previously accumulated own experience in assessing in the field of economic security. When forming the information base of the study, official statistical data were used to calculate the integral assessment of industrial safety after their corresponding normalization. The empirical basis for calculating the index and the characteristic values of its identification are given in Tables 4–5).

The nature of changes in the index for 2011–2020 is not constant. An essential moment in the history of the metallurgical industry of Ukraine was 2016. During this period, the integral indicator is higher than the average value (satisfactory level). This is the period when Ukraine reduced the difference in crude steel production with China and Russia. However, already in 2017, the metallurgical industry of Ukraine is moving to a critical level due to a decrease in the level of competitiveness of Ukrainian steel products, a reduction in demand for it, increased state protectionism in the United States and Egypt, and state programs in China.

To consolidate the position of metallurgical enterprises on the world stage, Ukrainian metallurgy should take into account the experience of state policy on the development of the metallurgical industry in export countries. Since 2004, steel companies from all over the world have reported to Worldsteel on the indicator of stable development. According to the analysts of the industry association Worldsteel, the indicators “Investment in new processes and products” and “Economic value distributed” testify to the degree of sustainable development of the economic activity of companies [20]. Investments in new processes and products include capital expenditures and R&D investments. These indicators influence the development trends of the metallurgical industry and the industry as a whole, but especially metallurgy needs an influx of investment. The experience of implementing industrial policy concerning the metallurgical industry in China emphasizes the effectiveness of using foreign scientific and technical innovations, creating powerful innovation departments for research work at universities and metallurgical corporations. A comparative analysis of such indicators with the integral indicator of industrial safety in the metallurgical industry of Ukraine for 2011–2020 (Fig. 4) indicates that due to physical and moral aging of the active part of fixed assets of enterprises, the consumable and environmentally hazardous technology of steel smelting in an open-hearth furnace and the lack of state policy regarding the development of the metallurgical industry in Ukraine, the level of this safety will continue to be at a low

Table 4

System of indicators for assessing the production safety of the metallurgical industry and their dynamics for 2011–2020

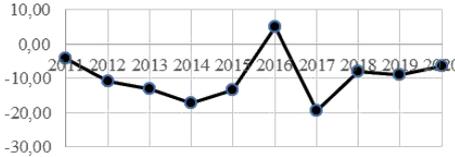
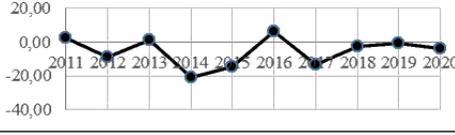
Indicator's code	Indicator	Units of measurement	Availability of the indicator in the National methodology in [13]	Dynamics of indicators
V1	Average ratio of crude steel production in Ukraine and crude steel production in selected European countries: Poland, Germany, Italy, Spain	%	not considered	
V2	The difference between the index of Ukraine and China (the growth rate of crude steel production in Ukraine, % to the corresponding period of the previous year – the growth rate of crude steel production in China, % to the corresponding period of the previous year)	percentage points	not considered	
V3	The difference between the index of Ukraine and Russia (the growth rate of crude steel production in Ukraine, % to the corresponding period of the previous year – the growth rate of crude steel production in Russia, % to the corresponding period of the previous year)	percentage points	not considered	
V4	Index of the cost of fixed assets in metallurgy (before the previous year)	%	not considered	
V5	Value Added Tax Index, VAT (compared to the previous year)	%	not considered	
V6	Index of tax paid by large taxpayers (up to the previous year)	%	not considered	

Table 5

The value of normalized indicators and an integral assessment of the production component of the economic security of the metallurgical industry

Indicator's	Years									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Z1	0.94	0.94	1.00	0.54	0.20	0.32	0.01	0.00	0.11	0.32
Z2	0.62	0.35	0.26	0.09	0.25	1.00	0.00	0.46	0.42	0.54
Z3	0.88	0.45	0.81	0.00	0.22	1.00	0.28	0.68	0.76	0.64
Z4	0.11	1.00	0.00	0.30	0.35	0.46	0.18	0.47	0.18	0.36
Z5	0.37	0.39	0.41	0.46	1.00	0.59	0.00	0.57	0.21	0.12
Z6	0.25	0.24	0.36	0.00	0.29	1.00	0.07	0.79	0.44	0.37
	<b>0.53</b>	<b>0.56</b>	<b>0.47</b>	<b>0.23</b>	<b>0.39</b>	<b>0.73</b>	<b>0.09</b>	<b>0.50</b>	<b>0.35</b>	<b>0.39</b>
Security level [13]	Unsatisfactory	Unsatisfactory	Unsatisfactory	Insecure	Insecure	Satisfactory	Critical	Unsatisfactory	Insecure	Insecure

level, which makes the metallurgical industry of Ukraine non-mobile and illiquid on the world market.

As indicated in Fig. 4, the level of development of the metallurgical industry in Ukraine significantly lags behind the global trends in the transformation of state and global economies in this sector. However, since 2014, there has been a cer-

tain correspondence between the level of production safety of the metallurgical industry of Ukraine and the generally recognized world indicators of the effectiveness of the development of this industry. This once again confirms the full compliance of the performance of the domestic metallurgical industry with world demands, but it does not, in any way, improve the

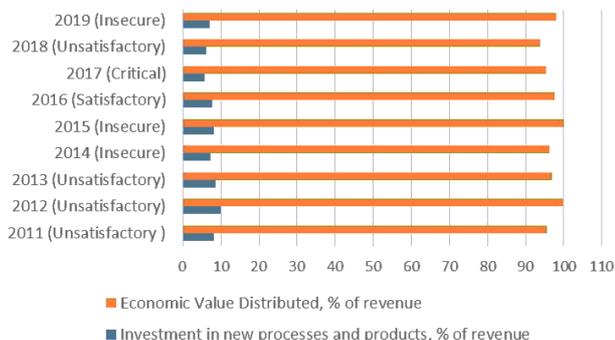


Fig. 4. Production safety levels of the metallurgical industry in Ukraine (shown in parentheses) and global indicators of economic activity development [9]

industry's position in the formation of an added product in the domestic market and does not increase the metallurgy's chances for competitive priorities in the foreign market. According to global trends in the transformation of the Industry 4.0 concept into the capitalism of stakeholders, the Ukrainian metallurgical industry has ceased to be a strategic component of the national economy, even with technological progress in the chemical industry and transformation in the extractive industry.

**Conclusions.** Despite significant improvements in sustainability and regulatory compliance, steel companies must continue to innovate and stay up to date with the latest developments. Capitalism of stakeholder is the idea that companies should strive to serve all stakeholders, not only shareholders, but also customers, employees, suppliers, and local communities. Accordingly, a significant amount of data is generated and accumulated in each industry, which is appropriate to digitalize in a short time to maximize the usefulness of the concept. The 2019–2021 pandemic period is the most favorable in this case. Most operations have been converted to digital form, and only a tiny proportion of them have a high level of cybersecurity. Currently, neural networks are learning to maximize utility. However, later (perhaps with the end of the pandemic), the digital level of maximization should be partially transformed into a tangible form.

The metallurgical industry of Ukraine is not yet ready to compete with foreign analogs. However, to monitor market priorities, we consider it appropriate to compare strengths and weaknesses and investigate the threats and advantages of the industry according to global competitors by taking into account the industrial safety index used in this article.

#### References.

- Worldsteel Association (2019). *The Role of Steel Manufacturing in the Global Economy. A Report for the World Steel Association. Oxford Economics*. Retrieved from <https://www.worldsteel.org/en/dam/jcr:fd44918-dc3b-455b-9083-f770afa4a214/OE%2520Executive%2520Summary.pdf>.
- Worldsteel Association (2020). *Steel Statistical Yearbook 2020 concise version. A cross-section of steel industry statistics 2010–2019*. Retrieved from <https://www.worldsteel.org/en/dam/jcr:5001dac8-0083-46f3-aadd-35aa357acbcc/Steel%2520Statistical%2520Yearbook%25202020%2520%2528concise%2520version%2529.pdf>.
- Lysachok, A. (2020). Innovative development in IT Sphere in the Context of the Industry 4.0 Concept: The Case of Ukraine. *International Journal of Advanced Trends in Computer Science and Engineering*, 9, 188–197. <https://doi.org/10.30534/ijatcse/2020/2891.22020>.
- Panfilova, E. S., Shoppert, K. A., & Lvova, M. I. (2019). Optimization problems of capital structure of metallurgical industry companies in the context of economy digitalization. In Nazarov, A. (Ed.). (2019). *Proceedings of the 1st international scientific conference "modern management trends and the digital economy: from regional development to global economic growth"*. AEBMR-Advances in Economics Business and Management Research, 81, 141–144. Atlantis Press. <https://doi.org/10.2991/mtdm-19.2019.26>.

- Resler, M., Kurylo, M., Logvinenko, M., Makhinchuk, V., & Ivanyshchuk, A. (2018). Analysis of current trends in innovation and investment activity of Ukrainian metallurgical enterprises. *Investment Management and Financial Innovations*, 15(2), 116–128. [https://doi.org/10.21511/imfi.15\(2\).2018.11](https://doi.org/10.21511/imfi.15(2).2018.11).
- Hrynyk, T. V., & Androsovs, I. O. (2019). Problems and prospects of development of metallurgical industry in Ukraine. *Problemy ekonomiky*, (2), 39–44. <https://doi.org/10.32983/2222-0712-2019-2-39-44>.
- World Trade Organization (2016). *Export Strategy of Ukraine: Strategic Trade Development Roadmap 2017–2021*. Retrieved from <https://cutt.ly/BWupqvr>.
- Gonchar, V. (2016). Forecasting as a method of metals marketing research. *Ekonomichnyi Visnyk Donbasu*, 4(46), 104–108.
- Worldsteel Association (2020). *Circular Economy – worldsteel*. Retrieved from <https://circulareconomy.worldsteel.org/>.
- Romanova, O., & Sirotin, D. (2019). Metal Industry Development in the Conditions of Formation of New Technological and Institutional Trends. *Theoretical and practical conference with international participation and School for young scientists "FERROALLOYS: Development prospects of metallurgy and machine building based on completed Research and Development"*, *K"E Materials Science*, 15–28. <https://doi.org/10.18502/kms.v5i1.3949>.
- Shvab, K. (2019). *What do we want? Three models of the future to choose from*. Retrieved from <https://cutt.ly/XnqNZWY>.
- Bykova-Fedorchuk, N., Goncharenko, O., Generalov, O., Donchenko, O., & Kravets, K. (2018). Metallurgical complex of Ukraine: dynamics and development prospects. *Problems and Perspectives in Management*, 16(2), 364–375. [https://doi.org/10.21511/ppm.16\(2\).2018.33](https://doi.org/10.21511/ppm.16(2).2018.33).
- The Ministry of Economic Development and Trade of Ukraine. (2013). *On the Statement of Methodical Recommendations on Calculation of Ukraine's Economic Security Level. Order, 1277*. Retrieved from <https://zakon.rada.gov.ua/rada/show/v1277731-13?lang=uk#Text>.
- 4 ways blockchain will transform the mining and metals industry (n.d.). Retrieved from <https://www.weforum.org/agenda/2018/07/4-ways-blockchain-will-transform-the-mining-and-metals-industry/>.
- GMK Center (2019). *How Ukrainian metallurgy opposes global protectionism*. Retrieved from <https://gmk.center/ua/infographic/yak-ukrainska-metallurgiya-protistoiit-globalnomu-protekcioniizmu/>.
- GMK Center (2021). *Forecast of steel production in Ukraine in 2021*. Retrieved from [https://gmk.center/wp-content/uploads/2021/02/Prognoz-steel\\_2021-02.pdf](https://gmk.center/wp-content/uploads/2021/02/Prognoz-steel_2021-02.pdf).
- Worldsteel Association (2021). *Monthly crude steel production in the 64 countries included in the report, in thousands of tonnes*. Retrieved from <https://cutt.ly/NWupxCr>.
- The State Statistics Service of Ukraine (2020). Retrieved from <http://www.ukrstat.gov.ua/>.
- Prices for raw material* (n.d.). Retrieved from <https://finance.liga.net/market>.
- Worldsteel Association (2020). *Worldsteel Sustainability Indicators*. Retrieved from <https://www.worldsteel.org/steel-by-topic/sustainability/sustainability-indicators.html>.

## Трансформація металургійної галузі України з концепції «Індустрія 4.0» до капіталізму стейкхолдерів

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**Мета.** Визначення рівня розвитку металургійної галузі України відповідно до загальносвітових тенденцій її трансформації з концепції «Індустрія 4.0» до капіталізму стейкхолдерів.

**Методика.** Для досягнення мети дослідження використана система загальнонаукових і спеціальних методів: узагальнення – під час компаративного аналізу конкурентних переваг окремих країн щодо реалізації концепції «Індустрія 4.0», для співставлення рівня виробничої безпеки металургійної галузі в Україні та світових індикаторів розвитку економічної діяльності; статистичні та економічні – методи аналізу динамічних рядів (для здійснення аналізу тенденцій основних показників експортоорієнтованих галузей України, знаходження показників описової статистики), методи нормування показників і інтегрального оцінювання (для оцінки виробничої безпеки металургійної галузі України); методи кореляційного аналізу (для визначення впливу експортоорієнтованих галузей України на ВВП, формування системи показників найбільшого впливу на виробничу безпеку в металургійній галузі). Використані методи графічної візуалізації інтегральної оцінки виробничої безпеки металургійної галузі України.

**Результати.** Показано, що для розвитку металургійної галузі України концепцію «Індустрія 4.0» доречно розглядати з позиції концепції «Капіталізм стейкхолдерів». Проаналізована динаміка виробництва сирової сталі за 2011–2020 роки, аналіз тенденцій якої продемонстрував зростання у країнах «капіталізму стейкхолдерів». Після порівняння та аналізу показників експортоорієнтованих галузей України визначено, що металургійна галузь має відносну стабільність на фоні світового зростання обсягів фінансування та кількості фундаментальних досліджень у розбудові складових концепції «капіталізму

стейкхолдерів». Сформована система індикаторів оцінки виробничої безпеки металургійної галузі України, ураховані дані країн, в яких намітилися риси капіталізму стейкхолдерів. Отримані результати аналізу інтегрального показника виробничої безпеки металургійній галузі України зі світовими показниками стабільного розвитку цієї галузі, дозволяють надати оперативну інформацію щодо результативності функціонування металургійної галузі України як однієї з провідних складових українського економічного форсайту.

**Наукова новизна.** Автори пропонують науковий підхід до трансформації металургійної галузі України відповідно до світових тенденцій розвитку галузі та пріоритетів, що визначені передовими країнами. Він ґрунтується на вдосконаленні інструментального апарату оцінки результативності трансформації металургійної галузі України від концепції «Індустрія 4.0» до концепції «Капіталізм стейкхолдерів» та науковому осмисленню рівня виробничої безпеки металургійної галузі в Україні та світових індикаторів розвитку економічної діяльності.

**Практична значимість.** Отримані результати створюють підґрунтя для розробки підходів до оцінювання виробничої безпеки металургійної галузі для забезпечення економічної безпеки галузі в цілому.

**Ключові слова:** *виробнича безпека, металургія, стейкхолдер, індикатори, інтегральна оцінка, соціетальний парадокс*

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