

Digital Technologies in Ensuring Financial Strength of Russian Non-Ferrous Smelters

Dolgikh Yu.A.* Panfilova E.S. Smorodina E.A.

Ural Federal University named after the first President of Russia B.N. Yeltsin, Yekaterinburg, Russian Federation

**Corresponding author. Email: rimdm@rambler.ru*

ABSTRACT

The relevance of this research depends, on the one hand, on the high level of importance of the non-ferrous industry sector for the Russian economy, and, on the other hand, on serious threats to the stable functioning of the industry in the near future. The article analyzes the dynamics and structure of non-ferrous metal production in Russia, the dynamics of export and import volumes and price trends in view of key aluminum and copper segments. The systemic intra-industry problems and external threats to ensure the financial strength of Russian non-ferrous smelters are highlighted, the negative impact of which is reflected in the negative dynamics of the main financial and economic indicators of the copper industry enterprises - the flagship of the Russian non-ferrous industry, its most export-oriented segment. In the scope of identified intra-industry problems and external threats, including the consequences of the COVID-19 coronavirus pandemic infection, the authors formulated the main directions for increasing the smelters' efficiency through the introduction of digital technologies.

Keywords: *non-ferrous industry, Russian enterprises, financial strength, digital technologies*

1. INTRODUCTION

The metal industry is a combination of the ferrous and non-ferrous industry sectors, includes interconnected industries, from mining of raw materials to manufacture finished products from ferrous and non-ferrous metals and their alloys. A high level of concentration and combination of production makes it possible to extract associated elements from metal ores, which during processing become products for the chemical industry, as well as raw materials for the construction industry. The metallurgical complex includes both mining and processing industries, which play a fundamental role in the development of the oil and gas sector, defense and mechanical-engineering complexes, space industry, automotive, industrial and civil engineering, and the pipe industry.

Herewith, the Russian metallurgical complex is characterized by a high level of social significance, due to its contribution to providing people with jobs; formation of the revenues of the federal, regional and local budgets, state extra-budgetary funds through appropriate tax revenues and insurance premiums; ensuring the development of one-factory towns and regions of mining and smelting enterprises presence by financing the construction and maintenance of social facilities.

A special place in the structure of the Russian metallurgical complex is occupied by the non-ferrous industry sector, the products of which are raw materials for production of structural materials that are diverse and unique in physical and chemical properties, which are most widely used in all sectors of the national economy. Non-ferrous industry includes copper, lead-zinc, nickel-

cobalt, aluminum, titanium-magnesium, tungsten-molybdenum industries, the production of precious metals, hard alloys, rare metals, diamond, and gemstone mining, and a number of other industries, depending on the type manufactured products.

The non-ferrous industry is one of the specialization branches of Russia in the modern international division of labor. Currently, the Russian Federation ranks second in the world (after China) in the production of aluminum and nickel; it ranks first in the export of these metals; Russia also ranks second in the world in the production (shipments) of titanium steel [1].

The modern achievements of scientific and technical progress, from space development to electrical engineering, chemical equipment, and radio electronics, are closely related to the development of non-ferrous metal production technology. For example, some long ago mastered metals and alloys, in particular aluminum and titanium, previously used mainly in aeronautical equipment, are now becoming one of the main structural materials in construction, engineering, and other industries.

Russian non-ferrous industry develops special coatings with protective and water-repellent properties, which at any time soon will become popular among consumers in the cable, automotive and other industrial sectors. Quasicrystals with a number of unique properties (magnetic optical properties, electrical conductivity, low thermal conductivity, low frictional factor), which, of

course, will be used in industry, can also be included in the achievements of the domestic non-ferrous industry.

Thus, the non-ferrous industry is one of the industries that produce strategically important and innovation-oriented products; therefore, its stable functioning and development plays a crucial role in ensuring diversification of the Russian economy and strengthening competitive positions in the world market.

At the same time, Russian non-ferrous industry enterprises are currently faced with a number of problems that are threats to their sustainable development. The research is devoted to the study of these problems and the

identification of areas for increasing the efficiency of non-ferrous industry enterprises using digital technologies.

2. METHODS

Research of the modern state of Russian non-ferrous industry should be started with an analysis of the dynamics and structure of non-ferrous metals production in Russia. The analyzed period covers 2014-2018 (Table 1).

Table 1 Dynamics and structure of non-ferrous metals production in Russia in 2014-2018, thousand tons

Metal name	2014	2015	2016	2017	2018
Heavy metals					
Refined copper	889.5	874.2	860.4	949.1	1039.2
Refined zinc	223.2	232.4	247.0	256.9	255.3
Refined lead	107.8	118.7	130.2	139.9	140.2
Refined nickel	235.5	232.2	189.0	219.2	211.0
Refined tin	0.6	0.9	0.7	0.7	0.7
Light metals					
Primary aluminum	3488.2	3530.4	3704.8	3730.7	3774.1
Titanium pigment dioxide	101.2	78.5	74.9	69.8	60.3
Precious metals and diamonds					
Refined gold	288.0	289.5	288.5	306.9	314.4
Refined silver	1069.3	1246.6	1088.9	1044.3	1120.0
Platinum group metals (platinum, palladium)	101.1	102.3	98.4	105.9	103.0
Diamonds, million carats	38.3	41.9	40.3	42.6	43.2
Refractory non-ferrous metals					
Molybdenum concentrate	7.4	7.6	7.8	7.5	5.6
Tungsten concentrate	5.6	5.5	6.4	4.6	5.6
Zircon concentrate	0.1	0.1	0.03	0	0
Rare earth metal concentrates	7.7	7.8	8.7	8.5	8.7

Table 1 shows that during the analyzed period 2014-2018 uneven, but mainly upward, dynamics of most non-ferrous metals production, except nickel, tin, titanium, molybdenum, tungsten, zirconium, is observed. It should be noted that stagnation or decrease in production volumes of tin, titanium, tungsten, and zirconium, is due to a shortage of the corresponding raw material base.

Aluminum and copper respectively dominate in the structure of light and heavy non-ferrous metals production. Both metals are widely needed both in the domestic Russian and in the global market. Aluminum is one of the main structural materials in the world and is second only after ferrous metals in terms of production and consumption volume. Copper is widely used in the electrical and electronic industries, construction, transport industry, engineering, and instrumentation, as well as for consumer goods production. Further increase in copper

consumption is expected in the future, the main catalyst of which will be the development of the electric transport industry. Production of an electric car requires three times as much copper as a car with a gasoline or diesel engine. Other “green” technologies also imply the large-scale use of copper [2].

Due to the predominance of aluminum and copper segments in the structure of the Russian non-ferrous industry, let’s consider them in more detail. We will correlate the volumes of aluminum and copper production with the corresponding volumes of their export and import in 2014-2018 (Figures 1, 2).

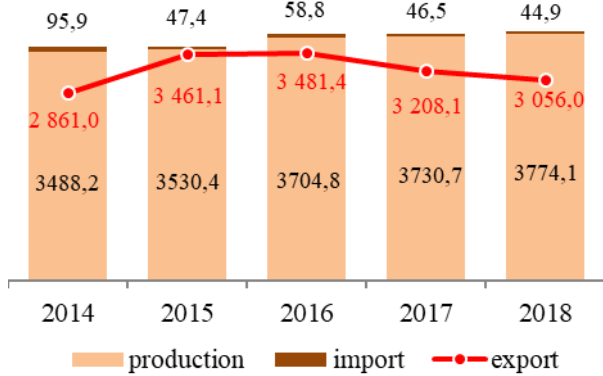


Figure 1 Dynamics of the Russian aluminum production, its export and import in 2014-2018, thousand tons

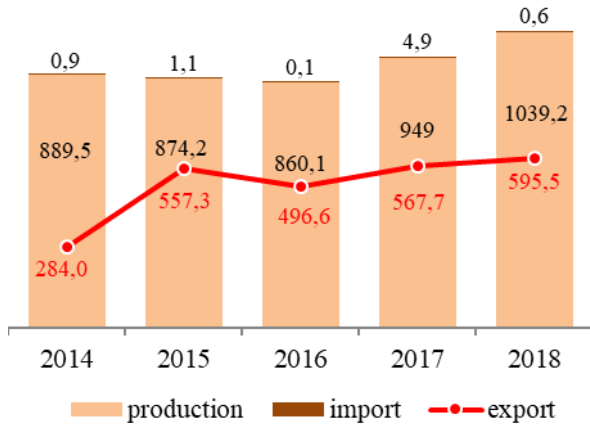


Figure 2 Dynamics of the Russian production of refined copper, its export and import in 2014-2018, thousand tons

Figure 1 demonstrates the positive trend of decrease in aluminum imports by 53% with the simultaneous increase in its exports by 6.8% in 2018 relative to 2014. However, the maximum export volumes of aluminum accounted for 2016. During 2017-2018 Russian metal export decreased by 12%, which was mainly due to a significant decrease in supplies to the USA as a result of protectionist measures by the USA government. At the same time, the USA is among the five countries with the largest volumes of imported Russian aluminum, along with the Netherlands, Turkey, Japan, and Switzerland.

Even more progressive dynamics is observed in Russian export of copper: over the analyzed 2014-2018 period its exports more than doubled, partly due to the abolition of the export duty on copper cathodes at the end of 2014. In 2017, Russia after Chile became the second exporter of refined copper in cathodes, maintaining this position in 2018. A significant increase in the exports of copper in cathodes also occurred due to a decrease in sales of copper wire rod, the sales market of which is more competitive and concentrated. Due to increase in the volume of Russian exports of refined copper, its geography also expanded: currently, the five largest importers include the

Netherlands, China, Germany, Switzerland, Egypt. With such impressive export volumes, imports of refined copper to Russia, mainly from Poland and Kazakhstan, are insignificant [2].

The dynamics of production and export-import volumes of aluminum and copper should be supplemented by an analysis of price trends for these metals in view of the global and domestic Russian market (Figures 3, 4).

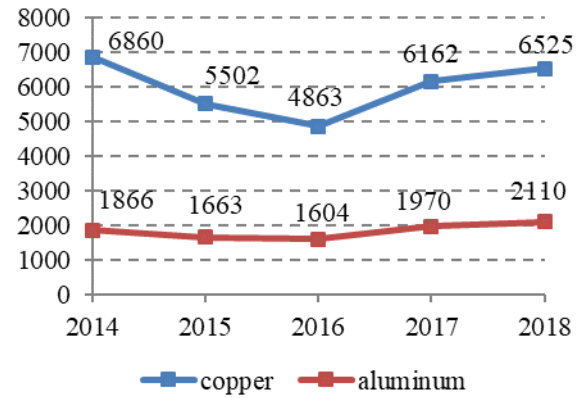


Figure 3 Dynamics of average annual prices (spot) for refined grade A copper and aluminum at the London Metal Exchange (LME) in 2014-2018, dollars/ton

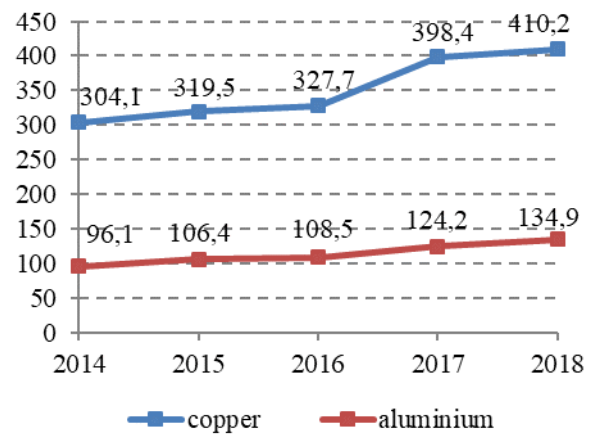


Figure 4 Dynamics of average annual prices for refined copper and aluminum in the Russian Federation in 2014-2018, thousand rubles/ton

High prices for aluminum in 2010-2011 after world economy recovered, they provoked the construction of new manufacturing enterprises and the rapid growth of aluminum production, which created its excess in the world market. This has resulted to lower prices. In 2016, the cost of one ton of metal decreased by 14% compared to 2014, and by 33% compared to 2011, which forced even large participants in the global aluminum market to reduce production capacities.

Since 2017, there has been a steady increase in prices, caused by another round of increase in demand. The favorable conjuncture was also due to the situation in China, where during 2017 about 10

million tons/year of “illegal” aluminum capacities were decommissioned and not allowed to be launched.

The decrease in aluminum prices growth rate in 2018 can be explained by the United States introduction of an additional customs tariff on the import of aluminum products for China, Canada, Mexico, and the European Union, as well as the general situation of market uncertainty due to trade rivalry between two major interested countries: the main global supplier of aluminum products is China and its main consumer is the United States.

The conjuncture of the Russian domestic aluminum market is characterized by less volatility and a steady increase in prices due to increased domestic demand, including due to increased production of new varieties of aluminum alloys in the Russian Federation used in construction and other industries.

Compared to the aluminum market, the global copper market is even more volatile. Having recovered from the global financial and economic crisis of 2008-2009, copper prices began the rapid increase and in 2011 reached a historic high (8821 dollars/ton), after which a long period of decrease began. The price increase trend appeared only at the end of 2016 and strengthened in 2017 caused by two main factors: the suspension of work at the largest copper mine in Escondida in Chile due to workers' strike, as well as an increase in global demand for copper from the electric transport industry. In 2018, price increase continued due to statements by large mining companies about the upcoming copper shortage due to the delay in

large projects development, but its pace was much lower, including due to the escalation of the trade conflict between the USA and China and the increase in investments in the copper mining industry of Latin America.

A tendency is observed in conjuncture of the Russian copper market in the period researched; tendency is similar to the dynamics of the Russian aluminum market: lower volatility and stable growth due to increased domestic demand for copper, especially in the cable and wire products manufacturing sector [7].

Comparing the price trends for aluminum and copper in view of the world and Russian markets, it can be noted that the copper segment is characterized by higher volatility, especially on a global scale. This circumstance is a significant risk factor in ensuring the financial strength of Russian copper industry enterprises, given that the share of copper exports in 2018 amounted to 57.3% of total Russian production.

For this reason, the authors found it in interest to analyze the financial status of the largest enterprises of the Russian copper industry by calculating its main indicators:

- current ratio;
- equity ratio;
- financial strength ratio;
- ratio of working capital with own sources of financing;
- return on assets [8].

The analyzed sample includes 10 largest enterprises of the Russian copper industry, which together account for more than 60% of the copper produced in Russia (Table 2).

Table 2 Dynamics of relative financial and economic indicators of the activities of Russian copper industry enterprises in 2014-2018.

Name of the enterprise (holding)	2014	2015	2016	2017	2018
Current ratio (standard ≥ 2)					
JSC “Uralelectromed” (UMMC JSC)	3.74	3.10	1.78	1.68	1.26
JSC “Safyanovskaya Med” (UMMC JSC)	1.18	3.11	4.32	1.51	1.41
JSC “Uchalinsky GOK” (UMMC JSC)	2.93	4.22	2.35	1.24	1.17
JSC “Sibaysky GOK” (UMMC JSC)	0.46	0.83	1.32	0.91	0.65
JSC “Sibir-Polymetals” (UMMC JSC)	0.84	0.48	0.77	1.44	2.01
PJSC “Gaysky GOK” (UMMC JSC)	0.99	1.18	1.26	1.16	0.67
JSC “ORMET” (RCC JSC)	2.80	5.74	11.32	9.52	10.49
JSC “Alexandrinskaya Mining Company” (RCC JSC)	0.12	0.24	1.05	1.80	0.18
JSC “Mikheevskiy GOK” (RCC JSC)	0.77	0.76	0.82	0.81	1.07
LLC “GRK Bystrinskoe” (PJSC MMC “Norilsk Nickel”)	0.41	15.77	1.44	0.84	0.57
Equity ratio (standard 0.55–0.7)					
JSC “Uralelectromed” (UMMC JSC)	0.75	0.76	0.72	0.67	0.60
JSC “Safyanovskaya Med” (UMMC JSC)	0.59	0.82	0.87	0.78	0.76
JSC “Uchalinsky GOK” (UMMC JSC)	0.89	0.76	0.73	0.69	0.70
JSC “Sibaysky GOK” (UMMC JSC)	0.80	0.83	0.87	0.84	0.78

JSC "Sibir-Polymetals" (UMMC JSC)	0.18	0.20	0,17	0.22	0,59
PJSC "Gaysky GOK" (UMMC JSC)	0,56	0.51	0.52	0,49	0.51
JSC "ORMET" (RCC JSC)	0,90	0,89	0,94	0,93	0,92
JSC "Alexandrinskaya Mining Company" (RCC JSC)	-8.24	-7.92	0.20	0.24	0.25
JSC "Mikheevskiy GOK" (RCC JSC)	-0.15	-0,18	0.06	0.03	0.18
LLC "GRK Bystrinskoe" (PJSC MMC "Norilsk Nickel")	0.85	0,98	0,71	0.44	0.25
Financial strength ratio (standard ≥ 0.8)					
JSC "Uralelectromed" (UMMC JSC)	0,88	0.86	0.79	0,81	0,73
JSC "Safyanovskaya Med" (UMMC JSC)	0.77	0,69	0.37	0,57	0,81
JSC "Uchalinsky GOK" (UMMC JSC)	0,87	0,89	0,88	0,69	0.79
JSC "Sibaysky GOK" (UMMC JSC)	0.85	0,88	0,93	0,91	0.84
JSC "Sibir-Polymetals" (UMMC JSC)	0.45	0,17	0.47	0.48	0.79
PJSC "Gaysky GOK" (UMMC JSC)	0.78	0.65	0.66	0.75	0.67
JSC "ORMET" (RCC JSC)	0,92	0,91	0,96	0,95	0,95
JSC "Alexandrinskaya Mining Company" (RCC JSC)	0.10	0,92	0,91	0,93	0.38
JSC "Mikheevskiy GOK" (RCC JSC)	0.75	0.75	0.79	0.76	0.78
LLC "GRK Bystrinskoe" (PJSC MMC "Norilsk Nickel")	0,87	0,98	0,92	0,91	0,90
Ratio of working capital with own sources of financing (standard ≥ 0.1)					
JSC "Uralelectromed" (UMMC JSC)	0.45	0.44	0,23	-0.05	-0.16
JSC "Safyanovskaya Med" (UMMC JSC)	0.11	0.06	0.72	0,23	0.16
JSC "Uchalinsky GOK" (UMMC JSC)	0,50	0.22	0.20	0.01	-0.49
JSC "Sibaysky GOK" (UMMC JSC)	-1.80	-1.70	-0.49	-0.91	-1.19
JSC "Sibir-Polymetals" (UMMC JSC)	-0.88	-1.07	-1.29	-0.55	-0.11
PJSC "Gaysky GOK" (UMMC JSC)	-0,22	-0.45	-0,33	-0.83	-1.04
JSC "ORMET" (RCC JSC)	0,54	0.79	0,88	0.85	0.86
JSC "Alexandrinskaya Mining Company" (RCC JSC)	-8.24	-7.92	-7.62	-5.35	-5.79
JSC "Mikheevskiy GOK" (RCC JSC)	-5.87	-5.18	-5.26	-3.9	-2.52
LLC "GRK Bystrinskoe" (PJSC MMC "Norilsk Nickel")	-1.76	0,93	-1.59	-5.45	-7.10
Return on assets, % (industry average standard $> 4\%$)					
JSC "Uralelectromed" (UMMC JSC)	-0.31	7.47	5.46	-1.79	3.12
JSC "Safyanovskaya Med" (UMMC JSC)	-5.81	-9.64	-2.58	-2.12	-1.68
JSC "Uchalinsky GOK" (UMMC JSC)	5.49	9.08	7.67	0.64	0.47
JSC "Sibaysky GOK" (UMMC JSC)	5.35	5.39	0.00	-6.90	-2.75
JSC "Sibir-Polymetals" (UMMC JSC)	-13.07	0,87	-1.79	1.45	0.37
PJSC "Gaysky GOK" (UMMC JSC)	-4.98	6.29	4.09	4.32	6.47
JSC "ORMET" (RCC JSC)	13.44	19.32	8.26	9.95	8.28
JSC "Alexandrinskaya Mining Company" (RCC JSC)	1.07	4.07	10.73	9.21	5.13
JSC "Mikheevskiy GOK" (RCC JSC)	-10.00	-2.85	13.71	9.34	14.56
LLC "GRK Bystrinskoe" (PJSC MMC "Norilsk Nickel")	-0.01	-3.50	0.58	-3.17	-4.12

Table 2 displays the unstable financial status of most of the analyzed enterprises. During 2017-2018 the current ratio characterizing the coverage of short-term liabilities with current assets was below the standard for 80% of the sample. The situation is more positive with equity ratio and financial strength ratio, reflecting the structure of liabilities of the analyzed enterprises: half of the sample has lower values of the corresponding indicators. At the same time, the values of the ratio of working capital with own sources of financing do not correspond to the standard for 80% of the sample, which reflects rather serious risks of liquidity and solvency of the analyzed enterprises. Analysis of the return on assets indicator values characterizing the ability of existing capital to generate profit also demonstrates a mismatch between the industry average standard and 60% of the sample (in addition, 40% of the sample shows losses during 2017-2018).

3. RESULTS

Results of the research conducted by the authors testify that currently Russian non-ferrous industry is in a very unstable state. Proof of this is the negative dynamics of the main financial and economic indicators of copper industry enterprises - the flagship of Russian non-ferrous industry, the most export-oriented segment.

This situation is caused, on the one hand, by the presence of systemic intra-industry problems, and, on the other hand, by the negative impact of external factors that pose serious threats to the functioning of the Russian non-ferrous industry enterprises.

The main intra-industry problems include:

- shortage of certain raw material categories (bauxite, tin, tungsten), underdeveloped raw material base (titanium, zirconium);
- high level of depreciation of fixed assets at most enterprises, which limits the output of marketable products with increasing processing depth;
- Increase of complexity and cost of extraction of non-ferrous metal ores due to the complication of mining and geological and mining-engineering conditions as fields are exploited;
- insufficient provision of enterprises with qualified workers and engineering personnel, low level of labor productivity;
- high dependence on mining equipment imports due to the underdevelopment of its own mining machinery manufacturing, and in this regard, the high cost of reproduction of fixed assets due to the devaluation of the national currency;
- low manufacturing of metal products with high added value, including from rare and rare earth metals;
- External threats to ensure the sustainable development of Russian non-ferrous industry include:

– the recession in the global and Russian economies due to the pandemic of the COVID-19 coronavirus infection,

causing a significant decrease in demand for non-ferrous metals in the near future;

- high volatility of the corresponding product segments of the global non-ferrous metal market;
- protectionist measures that apply to the key segments of the global market for Russian non-ferrous industry (more than 50 trade barriers and other measures of trade protection for Russian metal products in the European Union and the USA);
- strengthening the role of China and other countries of the Asian region in the world market of non-ferrous metals;
- high cost of attracted credit resources;
- significant tax burden, increase in royalty and negative environmental impacts due to tightening environmental standards;
- increasing market requirements for metal products quality.

4. DISCUSSION

Among the aforementioned problems and threats to the domestic non-ferrous industry, the greatest danger, of course, is the decrease in demand for non-ferrous metals in the world and Russian markets due to the recession of the global and national economies due to the COVID-19 coronavirus infection pandemic. The industry under research, which is already in a rather unstable state, was not ready for such a negative scenario.

In the authors' opinion, the key vector in the transformation of the Russian non-ferrous industry is its digitalization. The introduction of digital technologies in domestic smelters will help to reduce costs and increase the efficiency of their activities in view of the following areas:

1. The introduction of models operating on the Big Data technologies and artificial neural networks will allow optimizing the supply of raw materials and other resources by calculating their optimal quantity, quality and cost in accordance with the characteristics that metal products made from these raw materials should have;
2. The use of computer vision technologies and sampling automation, and research of quality samples contribute to increasing the speed of identification of technological business processes deviations, significantly reducing wasteful expenditure and recycling rejected products at most metallurgical treatments;
3. Formation of a digital ecosystem of interaction with customers based on software products and modules of ERP systems will simplify and speed up the placement of orders, increase the convenience of tracking the execution status, provide control over mutual settlements and effectively manage receivables;
4. The implementation of predictive analytics projects, the provision of repair and maintenance personnel with movable workplaces, the use of digital tools for integrated planning and intelligent management of spare parts availability, 3D printing technology will improve the

quality and efficiency of repair and other supporting business processes;

5. Automation and robotization of administrative business processes (planning, analysis, control) using RPA, digital labor, intelligent automation, process mining technologies will significantly reduce the number of personnel in economic and financial services at smelters [10].

Currently, digital transformation initiatives are already being implemented by the world's largest metals companies, for example, the Tata Steel's "Plant of the Future", Rio Tinto's "Mine of the Future" projects. Russian non-ferrous metals companies that are more conservative in this area should follow the example of foreign competitors as soon as possible. Otherwise, they cannot cope with today's critical challenges and threats, especially the consequences of the COVID-19 pandemic.

5. CONCLUSION

The results of the author's research, devoted to the analysis of the current state of Russian non-ferrous industry, demonstrated the extreme vulnerability of this industry to the modern threats and consequences of the new coronavirus infection. In this vein, ensuring the competitiveness of Russian metal products by improving its quality and significantly reducing costs due to the introduction of digital technologies does not seem to be a possible scenario, but an objective necessity.

REFERENCES

- [1] Ob utverzhdenii Strategii razvitiya chernoy metallurgii Rossii na 2014–2020 gg. i na perspektivu do 2030 g. i Strategii razvitiya tsvetnoy metallurgii Rossii na 2014–2020 gg. i na perspektivu do 2030 g.: prikaz Minpromtorga Rossii ot 05.05.2014 № 839 [Elektronnyy resurs]. Rezhim dostupa: <http://base.consultant.ru>.
- [2] O sostoyanii i ispol'zovanii mineral'no-syr'yevykh resursov Rossiyskoy Federatsii v 2018 g.: gosudarstvennyy doklad Minprirody, M.: FGBU «VIMS», 2019. 424 s.
- [3] Tamozhennaya statistika vneshney torgovli. Federal'naya tamozhennaya sluzhba. [Elektronnyy resurs]. Rezhim dostupa: <http://www.customs.ru/>
- [4] Proizvodstvo osnovnykh vidov produktsii metallurgicheskogo proizvodstva. Federal'naya sluzhba gosudarstvennoy statistiki (Rosstat). [Elektronnyy resurs]. Rezhim dostupa: <http://www.gks.ru/>
- [5] Promyshlennoye proizvodstvo v Rossii. 2016: Stat. sb., pod red. A.L. Kevesh, M.: Rosstat, 2016. 347 s.
- [6] Promyshlennoye proizvodstvo v Rossii. 2019: Stat. sb., pod red. I.D. Masakovoy, M.: Rosstat, 2019. 286 s.
- [7] Shoppert K.A. Optimization problems of capital structure of metallurgical industry companies in the context of economy digitalization, K.A. Shoppert, E.S. Panfilova, M.I. Lvova, Proceedings of the 1-st International Scientific Conference «Modern Management Trends and the Digital Economy: from Regional Development to Global Economic Growth» (MTDE 2019). 2019. vol. 240. P. 141-144.
- [8] J.A. Dolgikh, Development of methodological tools assessment of financial stability of enterprise, J.A. Dolgikh, J.E. Slepuhina, Advances in Social Science, Education and Humanities Research. 2019. vol. 240. P. 146-150.
- [9] Informatsionnaya sistema Kontur. Fokus. [Elektronnyy resurs]. Rezhim dostupa: <https://focus.kontur.ru/>
- [10] J. Reimann, G. Sziebig, The intelligent factory space – a concept for observing, learning and communicating in the digitalized factory, IEEE ACCESS. 2019. Vol. 7. P. 70891-70900.