

## Assessment of Aspects of the COVID-19 Crisis in the Context of Ensuring Economic Security



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### ABSTRACT

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*real sector economy, COVID-19, pandemic, crisis, economic security, hierarchical ordering method, crisis aspect*

The purpose of the article is to assess the main aspects of the crisis caused by COVID-19 and the onset of a pandemic in the real sector of the economy in the context of ensuring economic security. The research methodology consisted of the application of methods of the hierarchical ordering of the impacts of the most significant aspects of the crisis caused by COVID-19 and methods of analysis and synthesis for evaluating statistical data. As a result, using the hierarchical ordering method, we identified the key and most influential factors and aspects of the crisis caused by COVID-19 and the onset of the pandemic in the real sector of the economy in the context of ensuring economic security. The study has limitations, which are that the analysis was based on data on Ukraine and its economic activity on the international market. Proposed a methodological approach to streamlining the negative impact of the crisis factors caused by COVID-19 can be used in the relevant government agencies. The novelty, which is presented in the article, has an original value, which consists in the systematization and analysis of data on the real sector of the economy for the period of the pandemic and the corresponding negative factors are highlighted. Also, their orderings were presented through the proposed model.

## 1. INTRODUCTION

The negative impact of the corona crisis on most sectors of the world economy, according to experts, will be worse than the effect of the financial and economic crisis of 2008, because the recovery will be longer and will require significantly larger resources. Despite the persistence of stable global demand for food products in the future, the increase in the presence of Ukrainian food products on world markets will be hampered by the insufficient range of deeply processed goods and the preservation of the raw material orientation of exports [1]. Under such conditions, even a significant increase in export volumes will not ensure qualitative changes in its structure and the required growth rates of foreign exchange earnings. Restricting the access of Ukrainian industrial products to world markets against the background of increased competition for sales markets is carried out not only by introducing tariff restrictions but also by creating non-tariff barriers. Thus, the transition to a carbon-neutral economy planned by the EU in the strategic document The European Green Deal by 2050 provides for the introduction of a duty on the import of products manufactured with high carbon border tax to the EU countries to protect national producers and prevent the withdrawal of environmentally productions abroad. Other countries may follow such an example. The financial crisis in the industry has been somewhat mitigated by the implementation of large-scale state infrastructure projects in Ukraine. For example, the development of educational

institutions, medical care and roads within the framework of the project of the President of Ukraine “Big Construction” can become an important tool for enhancing domestic demand for construction, metallurgical, machine-building and other types of industrial products of national manufacturers. The threat of a shortage of financial resources over the next years will remain relevant even for the world’s most economies [2].

In the real sector of the economy under the conditions of COVID-19 in the context of ensuring economic security, systemic problems are associated with the rapid decrease in the role of industry in ensuring economic growth (which is a consequence not so much of the development of the service sector as the rapid loss of competitive positions of the Ukrainian industry both in the domestic and foreign markets), large-scale agrarianization, which occurs due to the unbalanced exploitation of the resource potential, as well as the insufficient role of the transport sector in meeting the needs of economic growth, the loss of the country’s transit potential [3]. The systematic underutilization of the potential of the Ukrainian industry to ensure economic growth is caused by the predominance of exogenous factors of its development, which form the critical dependence of the national economy on fluctuations in the external economic situation and the economic policy of trading partners. At the same time, the imperfect institutional organization of the economy, the dominance of big business in sectoral markets against the background of insufficient use of the potential of the science sector led to further monopolization and oligarchization of the

economy, slowing down structural changes and reducing the effectiveness of state industrial policy.

A wide range of long-term problematic issues remains in the transport sector of Ukraine, which impedes not only its development but also act as factor of slowing down the economic growth of the entire national economy. The integration of the domestic transport sector into the European transport network TEN-T is proceeding very slowly, cooperation within which, according to the indicative investment plan of the Eastern Partnership states within the framework of TEN-T, can bring Ukraine almost 4.5 billion USD of investments until 2030. to the port industry, air transport, and sluice facilities. The lack of effective integration into global infrastructure projects negatively affects the time and resources required for transportation, worsens the performance of domestic transport, and does not allow the most efficient use of the already existing capacity of the transport systems of Ukraine. In general, such cooperation will stimulate the inflow of investments in the domestic transport sector, contribute to its renewal and modernization, and increase competitiveness, efficiency, and safety [3].

More than a third of the gross value added of the economy is created in the sector, therefore ensuring sustainable socio-economic development of Ukraine depends on its functioning. In 2020, crisis trends have developed in the sector of the Ukrainian economy caused by the impact of the COVID-19 pandemic. At the end of 2020, the drop in production in industry was 5.2%, in agriculture - 11.5%, the volume of freight traffic decreased by 10.6% (excluding pipeline transport), passenger traffic - by 39.7%. The rate of growth recovery will depend on the effectiveness of government policy toward both countering existing risks and overcoming deep systemic problems [3].

The structural imbalance of industry leads to its inability to adequately respond to market needs in new conditions, to ensure demand for both consumer and investment products, making it impossible to achieve the rates of economic growth necessary for economic recovery. The work of agriculture is affected by the crisis trends in the livestock industry, as well as the unreformed agro-industrial sector of the economy as a whole, which manifests itself in particular in unpredictable changes in state regulation of the agricultural business and leads to a distortion of the structure of agricultural production - bias towards the cultivation of highly profitable export-oriented agricultural crops of grain and oilseeds. groups, often with disregard for environmental compliance. The transport infrastructure is on the verge of depreciation of fixed assets and the maximum permissible manufacturability.

The declarative nature of infrastructural modernization without securing funding for strategic projects has led to a critical depletion of infrastructure potential and, without a dramatic increase in investment, can lead to catastrophic consequences. The transport sector of Ukraine today satisfies only the basic needs of the economy and the population in transportation, while the quality indicators in terms of speed, efficiency, and safety of transportation do not yet meet modern requirements. High wear and tear of rolling stock, track, port, lock facilities, highways, increase the cost of other sectors of the economy, having a harmful and dangerous effect on the environment and reducing the export and transit potential of the country.

The protracted hybrid aggression on the part of the Russian Federation forces Ukraine to rethink the old and define new priorities of economic policy in the real sector, which should

result in leveling the destructive consequences of the aggressor's actions. The struggle of Ukraine against the pressure of the Russian Federation in the conditions of ever-decreasing profitability and predictability of Russian markets should be aimed at depriving the deep-rooted dependence on them and include the entire arsenal of available and effective measures of macroeconomic and foreign trade policy, economic diplomacy and international trade law.

All statistics presented in the introduction were taken from official statistics and government sources. All conclusions that were made in accordance with these data are the result of the theoretical research and constitute the authors' own scientific opinion, which was formed in compliance with all ethical standards of scientific research.

The purpose of the article is to assess the key aspects of the crisis caused by COVID-19 and the onset of a pandemic in the real sector of the economy in the context of ensuring economic security.

## 2. LITERATURE REVIEW

The COVID-19 pandemic has shocked national economies across the planet. Many analysts agree that this led to the worst economic crisis since World War II.

The virus has spared few, if any, escaped. COVID-19 has affected almost all states: more than 240 million people worldwide have been infected, according to the latest data. More than half of the world's population has faced quarantine measures to one degree or another, including restrictions on movement. Such harsh measures were taken for the first time in history.

Some governments have begun massively introducing social transfers to support businesses, households and vulnerable populations. In total, since March 2020, these costs have amounted to about US \$23 trillion. The infusion of government funds did not stop the decline (and sometimes almost complete collapse) of national economies, because the usual economic processes, travel, and supply chains were blown up. World GDP is expected to fall 4.5% next year, according to the OSCE forecast [4].

The spread of the coronavirus and the restrictive measures introduced everywhere in countries, along with the self-restraint of the population, have simply had a rapid impact on both national economies and the global economy as a whole. The pandemic and related restrictions have had a negative impact on macroeconomic performance. All regions of the world are experiencing recessions. And like any economic crisis, it is characterized by a decline in production volumes, an increase in unemployment, and a decrease in investment activity.

Scientists from all over the world devote their scientific work to the study of problems associated with the real sector of the economy and the negative impact of the pandemic on it.

For example, Blikhar et al. [5] investigated the state of the real sector of the economy even before the start of the pandemic, and for our study, it was interesting, because in this way you can see how everything changed due to the pandemic crisis. A similar study can be traced back to Dormady et al. [6].

Kopytko et al. [7], Ginevičius and Krivka [8], and Jakutis and Kazlovas [9] considered the characteristics of individual sectors of the economy and the problems were before the start of the pandemic.

According to many works [10-14], it was possible to

emphasize many features and factors about the real sectors of the economy and what was the state of things then, the pandemic and the COVID-19 crisis.

How COVID-19 and its consequences changed the business environment and significantly damaged the indicators of the real sector of the economy, was also the attention of scientists. So, for example, Cohen et al. [15] predicted these kinds of scenarios. Interesting are the results of the Ker [16] study on the agricultural sector of the economy and how the pandemic affected the Canadian economy. Other sectors of the economy have also been the focus of scientists [17, 18]. And then, the negative results are shown by the world due to the coronavirus pandemic, also deserve attention [19].

Today, in 2021, there is also enough research on this topic. We analyze the security challenges associated with the pandemic [20].

However, paying tribute to the scientific extraction of leading scientists and practitioners, it should be noted that today, there is no approach to the improvement of the negative impact of the crisis factors caused by COVID-19 in the context of ensuring economic security, and this became our task.

### 3. METHODOLOGY

Our research involves assessing the key aspects of the crisis caused by COVID-19 and the onset of the pandemic in the real sector of the economy in a business environment. To achieve this goal, we have applied several basic methods and formed our methodology.

For the first part of our study, we applied methods of analysis and synthesis of the information to assess statistical data to determine the current state of the real sector of the economy in the country during the pandemic and before its appearance. Using analytical methods makes it possible to better reflect changes in the real sector of the economy in dynamics.

As a result of the first part of the study, the second part is formed, which provides for the determination, based on the results of analysis and a survey of experts from the expert assessment method, of the main aspects of the crisis that have the greatest impact on the real sector of the country's economy due to COVID-19. In order to understand which ones have the most negative impact, and which ones have less, the method of the hierarchical ordering of this influence was applied using graph theory. In fact, the method of graph theory and graphs of connections, it is very common in scientific works, tools that can be found in the economic sphere. It is in this context that it is best to use the methodology of the theory of networked systems. The entire set of certain aspects was conditionally designated through a certain set  $Z=\{z_1, z_2, \dots, z_n\}$ , that is, its mathematical designation was provided.

As a result, because of the application of the modeling method and the corresponding modern programs, a suitable model of the influence hierarchy was formed.

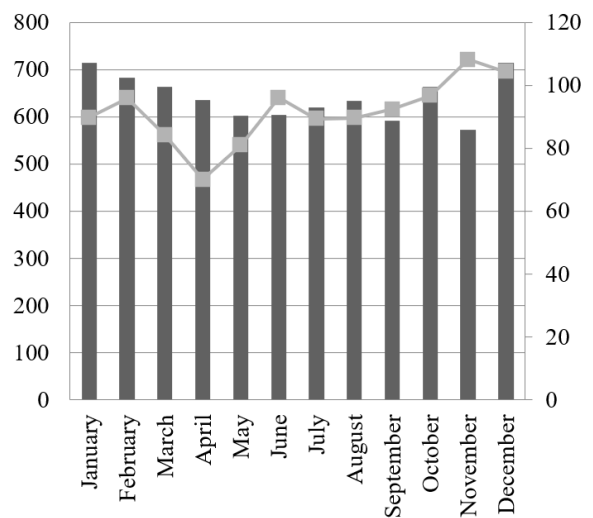
The model was formed on basic mathematical calculations, the main results of which are depicted in the course of work using graph theory. This modeling process is not new, but its application is new for our study.

### 4. RESULTS OF RESEARCH

The global coronavirus pandemic has deepened the global

slowdown in economic dynamics. Under these conditions, the openness of the Ukrainian economy, its dependence on exports and raw material prices led to a quick negative reaction from the basic export-oriented industries of the industry. Analysis of the export of industrial products indicates a decrease in export flows of investment products of the metallurgical and machine-building industries, while the export volumes of raw materials and food products, on the contrary, predominantly demonstrated growth. Our goal was not to demonstrate a direct comparison of the economy before and during the pandemic. We just wanted to emphasize that the economic situation before and after covid is fundamentally different.

In total, in 2020, compared to 2019, Ukraine's external trade turnover (in USD) decreased by 6.4%, and the volume of merchandise exports - by 1.7% 8. In particular, the export of ferrous metals in 2020 compared to 2019 decreased by 12.1%, products made of ferrous metals - by 14.9%, organic chemicals - by 21.7%, inorganic - by 6.8%, electrical goods - by 5.9%. Among technological products with relatively high added value, export volumes increased in group 88 (aircraft, spacecraft and their parts) - by 131.0%, group 89 (ships, boats and other floating equipment) - by 8.2%, group 31 (mineral fertilizers) - by 67.5%, group 30 (pharmaceutical products) - by 6.9%, group 84 (nuclear reactors, boilers and machines) - by 6.7%. In the context of global uncertainty, negative dynamics can quickly spread to other industrial industries with a high dependence on export markets, which are certain subsectors of the extractive, light, woodworking, and other industries (Figure 1).



**Figure 1.** Industrial production indices in metallurgy, percent to the corresponding month of the previous year (main axis) and exports of ferrous metals, USD million (minor axis) (developed by authors)

In metallurgy, the peak drop in production fell on March-May, which was caused by a combination of the following internal and external factors:

- a decrease in demand for metal products in the world due to the shutdown of rolling mills, which are the main consumers of Ukrainian steel semi-finished products; stopping an unprecedented number of car factories in Europe, reducing the number of drilling rigs due to falling oil prices, reducing the demand for tubular products, etc.;

- the global fall in prices for metal products and scrap metal, which is actively used by Ukraine's competitors as raw materials for metallurgy. As a result, domestic enterprises

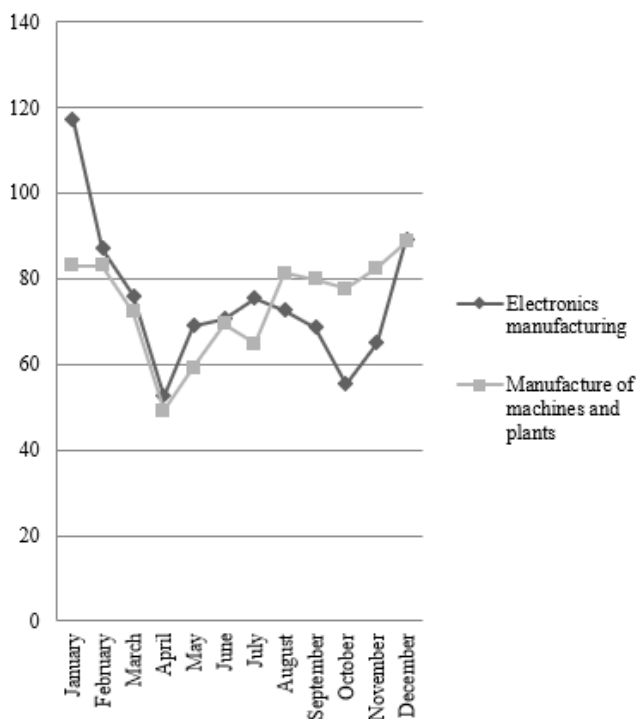
mainly use much more expensive iron ore raw materials for scrap metal, lose their price competitiveness in world markets;

-significant protectionist restrictions on the export of Ukrainian metal products from the EU countries, the USA, the Eurasian Economic Union, India, Pakistan, Egypt, Canada, and the like. Coronacrisis has given rise to new initiatives to implement import and protective restrictions;

-aggravation of internal logistic problems of Ukrainian metallurgical enterprises due to frequent delays in fulfilling their orders for the transportation of products by state transport companies and seaports, which leads to a slowdown in production processes and untimely fulfillment of obligations to counterparties.

However, already in June 2020, the rate of decline in production in the industry slowed down somewhat, and the export of ferrous metals, which is the second-largest group of Ukrainian exports after grain, showed growth in the summer months, which was primarily explained by the recovery of deferred demand for steel and cast iron products from outside. China, which is significantly ahead of other countries in terms of economic recovery. The recovery in demand helped to mitigate the negative dynamics in the production of main types of products at the end of 2020.

The coronavirus pandemic has exacerbated negative trends in mechanical engineering, which has been in crisis for many years. The industry showed the worst results in April 2020, when all subsectors underwent a sharp decline (Figure 2). The decisive factor in the deepening of the crisis was the reduction in both internal and external demand for investment engineering products (industrial equipment, vehicles, etc.) and for products for end consumers (cars, household appliances) in the context of global uncertainty. Since May, the depth of the fall has been decreasing in all subsectors, but the increase in production has occurred only in the production of electrical equipment.



**Figure 2.** Industrial production indices in the mechanical engineering subsectors in 2020, percent to the corresponding month of the previous year (*developed by authors*)

The coronavirus pandemic, as well as quarantine, negatively affected both the situation of agricultural producers (including small farms) and consumers of agricultural products.

Trade-in most of the retail agricultural markets in Ukraine was stopped during the spring. Considering that, according to expert estimates, it is in the food markets that up to 85% of early vegetables and berries are usually sold, this caused problems with the sale of grown products, deprived consumers of food sources, and put small farmers in a difficult financial situation. This information was taken from the main analytical and statistical data of the State Statistics Service of Ukraine [3]. In general, the most tangible negative effects of the introduction of quarantine measures for the agricultural sector were the following:

- narrowing of sales channels for agricultural producers. If the chains “producer-processor-grocery stores” or “manufacturer-grocery store” with the use of quarantine measures were preserved, then the chains “Manufacturer - catering establishment” or “producer-producer of semi-finished products/manufacturer of fast food” were violated. Small-scale producers suffered significant damage from the ban on agricultural markets and traditional weekly agricultural fairs, as well as those who supplied their products to restaurants, fast-food establishments, and other establishments that were closed during quarantine;

- partial or complete loss of harvest of early seasonal labor-intensive agricultural products by agricultural producers due to the impossibility of attracting additional seasonal personnel by enterprises to carry out sowing and harvesting operations;

- deterioration in the diet of the population due to the shortage of early agricultural fortified products and high prices for the corresponding imported products, a decrease in the range of food products (after all, the population was forced to buy food only in grocery stores);

- an increase in the deficit for components of feed for farm animals through the speculative actions of their producers in the domestic market and an increase in the cost of foreign products;

- shortage of workers in the collection of early fruit and berry crops. If in previous years the shortage of personnel in this area was mainly associated with the departure of the labor force abroad, then this year - their shortage is caused by the introduction of quarantine requirements to limit the number of simultaneously working workers.

Transport is one of the sectors most affected by the COVID-19 pandemic due to the inability to carry out its main activity. The greatest losses were recorded in passenger transport as a result of the introduction of restrictions on transportation by all modes of transport, except for private road transport. In general, during March-October 2020, there was a decrease in the number of passengers carried by 51.0%, or by 1,398,200,000 passengers. After the introduction of adaptive quarantine (in May 2020), there was a gradual increase in the volume of transported goods and the number of passengers transported. Ensuring economic growth in the transport sector of the Ukrainian economy is extremely important through the multiplier effect that it provides for the functioning of the entire economy. Well-developed and efficient transport in itself can be a driver of economic growth and a factor in increasing the competitiveness of domestic producers. On the other hand, disproportionate, worn out and outdated transport significantly limits the possibilities for economic growth, investment attractiveness of the country and hinders the

development of national production. Unfortunately, today it is the second scenario that is observed in Ukraine, illustrated by the ongoing reorientation of freight flows on economic rail transport to more expensive road transport, the inability of seaports to process cargo in the required volumes, scanty use of the potential of river transport, a low degree of integration of the domestic transport system to the world infrastructure projects, loss of transit cargo flows, barely noticeable innovative activity and too high share of transport and logistics costs in the total cost of domestic products.

Among the aspects related to the impact of the COVID-19 pandemic, which negatively affected the transport sector in Ukraine, it should be noted that credit ratings have been lowered and the ability of Ukrainian transport companies to attract investment. So, in April 2020, the international rating agency S & P Global Rankings downgraded the credit rating of Ukrzaliznytsia State Enterprise from B- to CCC with a negative outlook. This was due to restrictions on the company's ability to generate financial flows sufficient to service its debt amid the coronavirus pandemic.

Based on the results of the analysis, we have identified the main aspects for each economic area, which, in our opinion, have the greatest negative impact on the real sector of the economy (Table 1).

**Table 1.** List of negative aspects of the coronavirus crisis on the real sector of the economy in the context of ensuring economic security and their mathematical designation (developed by the authors)

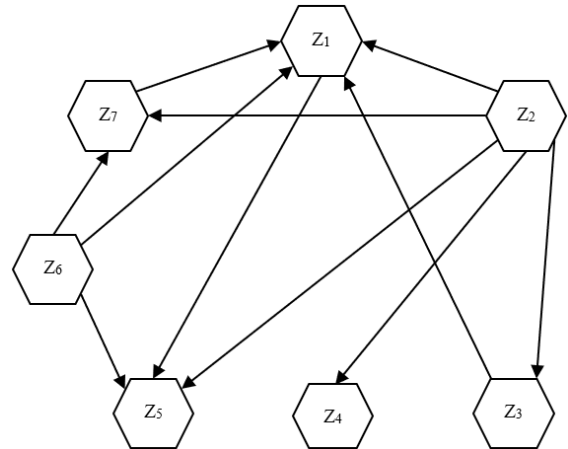
Mathematical notation	Crisis aspect name
Z <sub>1</sub>	decrease in demand for metal products in the world due to the shutdown of rolling mills
Z <sub>2</sub>	narrowing of sales channels for agricultural producers
Z <sub>3</sub>	global fall in prices for metal products and scrap metal
Z <sub>4</sub>	disproportionate, worn out, and outdated vehicles
Z <sub>5</sub>	downgrading of credit ratings and the ability of Ukrainian transport companies to attract investment
Z <sub>6</sub>	deterioration in the diet of the population due to the shortage of early agricultural fortified products
Z <sub>7</sub>	reduction of both internal and external demand for investment engineering products

We tried to analyze each element of the real sector of the economy in Ukraine and highlight the most significant aspects of the crisis and those factors that have the most negative impact on the real sector of the economy today. So, let's apply the graph theory and the method of hierarchical ordering, which were described in the section "Methods" by us above.

The first step will be the formation of the so-called graph of connections between the highlighted aspects of the coronavirus crisis in the real sectors of the economy. The mathematical notation for each aspect will be used instead of its long name. These mathematical notations are presented above in Table 1.

Thus, we have a subset of Z<sub>1</sub> and possible relationships with this sawdust, respectively. The vertex of the graph itself will include Z<sub>1</sub> and arcs that will connect the sum of the pairs of vertices (z<sub>i</sub>, z<sub>j</sub>) for which the same connection is defined. The connection will be shown through the arrows. The graph itself of the fundamental connections between the highlighted aspects of the coronavirus crisis in the real sectors of the economy is shown in Figure 3.

The next step is to build a binary matrix. Mathematically, let us denote it as the dependence matrix A for the set of vertices Z<sub>1</sub>, which must fulfill the condition under which: 1, this is when the vertex and depends on the vertex j and 0 if it does not, respectively.



**Figure 3.** Graph of relationships between aspects of the coronavirus crisis in the real sector of the economy (developed by authors)

So, the Binary matrix of dependence A, presented in Table 2.

**Table 2.** Binary dependence matrix (developed by authors)

	Z <sub>1</sub>	Z <sub>2</sub>	Z <sub>3</sub>	Z <sub>4</sub>	Z <sub>5</sub>	Z <sub>6</sub>	Z <sub>7</sub>
Z <sub>1</sub>	0	0	0	0	1	0	0
Z <sub>2</sub>	1	0	1	1	1	0	1
Z <sub>3</sub>	1	0	0	0	0	0	0
Z <sub>4</sub>	0	0	0	0	0	0	0
Z <sub>5</sub>	0	0	0	0	0	0	0
Z <sub>6</sub>	1	0	0	0	1	0	1
Z <sub>7</sub>	1	0	0	0	0	0	0

On the basis of the established by us matrix of dependence A, we form the following matrix - reach. So, we get a matrix (I + A), where I is the identity matrix. The reachability matrix itself must satisfy condition (1):

$$(I + A)^{k-1} \leq (I + A)^k = (I + A)^{k+1} \quad (1)$$

For the access matrix, the condition of which we obtain, 1 means that from i it is possible to get into j, but if not, then 0 is obtained (Table 3).

**Table 3.** The reachability matrix (developed by authors)

	Z <sub>1</sub>	Z <sub>2</sub>	Z <sub>3</sub>	Z <sub>4</sub>	Z <sub>5</sub>	Z <sub>6</sub>	Z <sub>7</sub>
Z <sub>1</sub>	1	0	0	0	1	0	0
Z <sub>2</sub>	1	1	1	1	1	0	1
Z <sub>3</sub>	1	0	1	0	0	0	0
Z <sub>4</sub>	0	0	0	1	0	0	0
Z <sub>5</sub>	0	0	0	0	1	0	0
Z <sub>6</sub>	1	0	0	0	1	1	1
Z <sub>7</sub>	1	0	0	0	0	0	1

Note, by its essence and methodology, the vertex z<sub>i</sub> itself is reached from the vertex z<sub>i</sub>, if there is the same path in the graph that leads from the vertex z<sub>i</sub> to the vertex z<sub>i</sub>. In this case, the vertex is called reachable. Let us denote such vertices as S(z<sub>i</sub>). Similarly, the vertex z<sub>i</sub> is the predecessor of the vertex z<sub>j</sub> if it reaches its vertex. Then we denote it as P(z<sub>j</sub>) (2):

$$R(z_i) = S(z_i) \cap P(z_i) \quad (2)$$

If there are peaks that are not reached from any of the peaks of the set  $Z_1$ , then they form a certain level of the hierarchy of influence referred to these peaks (3):

$$P(z_i) = R(z_i) \quad (3)$$

So, the calculation table for building a model of the hierarchy of impact, shown in Table 4.

**Table 4.** Calculation table for building a model of the hierarchy of the impact of the main aspects of the crisis caused by COVID-19 on the real sector of the economy (developed by authors)

I	S(z <sub>i</sub> )	P(z <sub>i</sub> )	S(z <sub>i</sub> ) ∩ P(z <sub>i</sub> )
1	1, 5	1, 2, 3, 6, 7	1
2	1, 2, 3, 4, 5, 7	2	2
3	1, 3	2, 3	3
4	4	2, 4	4
5	5	1, 2, 5, 6	5
6	1, 5, 6, 7	6	6
7	1, 7	2, 6, 7	7

The second column of this table is the numbers of single elements of the corresponding rows of the access matrix, the third is the numbers of single elements of the columns of this matrix. We see that the establishment of equality according to formula (3) is carried out for the 2nd and 6th aspects of the crisis, that is, according to our mathematical notation, these are  $Z_2$  and  $Z_6$ . They form a low priority level of influence on the real sector of the Ukrainian economy. It should be noted that we did not aim to reduce their importance and impact on the real sector of the economy. All certain factors already a priori have one of the greatest influences on the real sector of the Ukrainian economy. However, compared to the other factors we selected, these factors have the least impact. Removing them from subsequent calculations, we get Table 5.

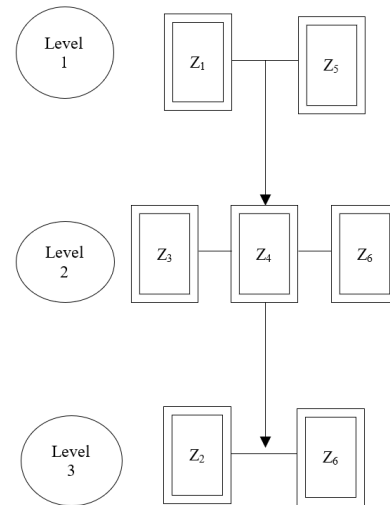
**Table 5.** Calculation table for building a model of the hierarchy of the impact of the main aspects of the crisis caused by COVID-19 on the real sector of the economy (developed by authors)

I	S(z <sub>i</sub> )	P(z <sub>i</sub> )	S(z <sub>i</sub> ) ∩ P(z <sub>i</sub> )
1	1, 5	1, 3, 7	1
3	1, 3	3	3
4	4	4	4
5	5	1, 5	5
7	1, 7	7	7

In this case, equality (3) already holds for  $Z_3$ ,  $Z_4$  and  $Z_7$ . They will form the second level of the hierarchy of influence. Without demonstrating further calculations, we can state that the highest level will be occupied by  $Z_1$  and  $Z_5$ . So, our model of the hierarchy of the impact of the main aspects of the crisis caused by COVID-19 on the real sector of the economy is shown in Figure 4.

Thus, according to our analysis, the priority measures in Ukraine to protect the real sector of the economy and its development in a pandemic should be aimed primarily at counteracting the aspects of the decline in demand for metal products in the world due to the shutdown of rolling mills and

a decrease in credit ratings and the ability of Ukrainian transport companies to attract investment.



**Figure 4.** Hierarchy model of the influence of the main aspects of the crisis caused by COVID-19 on the real sector of the economy in the context of ensuring economic security (developed by authors)

## 5. DISCUSSIONS

The research topic we have chosen is very relevant because the crisis is caused by the emergence of the COVID-19 virus here and now and has gone nowhere yet. The results of our study allow us to take a fresh look at the state of the real sector of the economy in such European countries as Ukraine, where the fight against the crisis caused by COVID-19 is at a low level in comparison with more developed countries such as the United States or Great Britain.

Many scientific works also deal with this problem and try to find their ways of solving it. For example, the shock effect of the COVID-19 crisis was discussed by Dixon et. al. (2020), but we tried not only to show this state but also to propose our methodological approach to streamlining the negative impact of the factors of the crisis caused by COVID-19.

In general, to consider what consequences the crisis caused by COVID-19 entails is a common phenomenon in the scientific literature today [21, 22], but not all highlight the key and most influential factors and aspects of the crisis caused by COVID-19. 19 and the onset of a pandemic in the real sector of the economy, and was done as a result of our research.

COVID-19 has become the world's number one problem and probably the biggest threat of the 21st century at present and of course, all sectors of the economy have felt the changes and consequences. Much is said about this in the scientific works of Mandel and Veetil [23], and Carlsson-Szlezak et al. [12], but then in 2020, this question still stood with some uncertainty about what the consequences would really be. Today, in 2021, we have more information on how the COVID-19 crisis could actually affect sectors of the economy.

In general, research on the example of Nikonenko et al. [24] are trying to determine the key factors affecting the economies of European countries, but as a result of systematization and analysis of data on the real sector of the economy for the period of the pandemic, we have identified the corresponding negative factors. Also, their orderings were presented through the proposed model.

## 6. CONCLUSIONS

We assessed the main aspects of the crisis caused by COVID-19 and the onset of the pandemic in the real sector of the economy in the context of ensuring economic security. Methods of the hierarchical ordering of the impacts of the most significant aspects of the crisis caused by COVID-19 and methods of analysis and synthesis were applied to evaluate statistical data.

As a result, we identified the key and most influential factors and aspects of the crisis caused by COVID-19 and the onset of the pandemic in the real sector of the economy in the context of ensuring economic security. The novelty, which is presented in the article, has an original value, which consists in the systematization and analysis of data on the real sector of the economy for the period of the pandemic and the corresponding negative factors are highlighted. Also, their orderings were presented through the proposed model.

The real sector in the conditions of COVID-19 requires the continuation of the initiated reforms and the acceleration of modernization shifts towards the full implementation of its investment, innovation, production, resource potential and strengthening on this basis the competitiveness of the economy, ensuring the socio-economic living conditions of the population that meet European standards. This requires updating the approaches of state policy to stimulate the modernization of the real sector based on ensuring a structural balance in the development of its industries for growth on an innovative basis, attracting and combining the efforts of all economic agents and sectors of the economy in the process of creating added value and equitably distributing income between them.

We can also talk about the practical side of the study. The proposed methodological approach to streamlining the negative impact of the crisis factors caused by COVID-19 can be used in the relevant government agencies. The use of this method can greatly facilitate the organization of public policy during a pandemic.

Of course, research has limitations. The study has limitations, which are that the analysis was based on data on Ukraine and its economic activity on the international market.

Further research should be devoted to the aspects of analysis and assessment of the real sector of the economy after the release from quarantine and return to normal business conditions in the context of ensuring economic security.

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