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SUPPLY CHAINS IN THE CROP PRODUCTION INDUSTRY OF UKRAINE: MAIN PARTICIPANTS AND PECULIARITIES OF INTEGRATION

Abstract

The aim of this article is to analyze the elements of supply chains in the crop production industry of Ukraine and the peculiarities of their integration under the modern conditions. The article identifies the main actors in the supply chains of major crops such as grains, sunflower seeds and vegetables. The study of supply chains in crop production covers three periods: (i) pre COVID-19 pandemic; (ii) the 2020-2021 COVID pandemic; and (iii) post-Russian invasion into Ukraine in 2022. The findings confirm that supply chains for vegetables were significantly and adversely affected by the COVID-19 pandemic. At the same time, the supply chains for production and sales of grains and sunflower seeds in Ukraine remained relatively stable. Through its global impact on the commodity markets, supply chains, inflation, and financial conditions, Russia's war against Ukraine is aggravating the slowdown in global economic growth. The article iden-

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tifies the negative consequences of this war for both Ukraine and the world as a whole based on the example of major agricultural crops. The development of crop production industry in Ukraine requires that supply chains be restructured based on the new logistical solutions adapted to the conditions of martial law.

Key Words:

COVID-19; crop production; grains; sunflower seeds; vegetables; logistics; participants; supply chain; war.

JEL: F1, F6, Q1, C5.

5 figures, 2 tables, 10 references.

Problem Statement and Literature Review

Under the conditions of world economy globalization, an important area of economic research is the problem of supply chain formation, with the focus of researchers being placed on ensuring the continuity of supply chains and the reduction of total costs throughout the entire chain from producer to consumer while meeting customer requirements for product quality.

Ukraine is a powerful producer and the world's leading exporter of crops. According to the data collected by the State Statistics Service of Ukraine, in 2019, crops accounted for almost 74% of Ukraine's total agricultural production (including grains (28%), industrial crops (24%); potatoes and vegetables (17%); fruits, berries, grapes (3.5%), and fodder crops (1%)). The structure of the sown areas under main crops has somewhat changed under the influence of natural and climatic conditions, peculiarities of production technology and changes in market conditions. However, these changes were insignificant. The study of major participants and peculiarities in the formation of supply chains for agricultural crops is a relevant topic, which deserves further research taking into consideration the market challenges brought by the COVID-19 and the Russian war in

Ukraine. During the war, the management of supply chains becomes substantially complicated in view of the need to develop new sales channels and to perform supply chain forecasting, at least over the short term period.

Throughout the last decade, the research of supply chains has received broad attention in economic literature. Much focus has been placed on the study of supply chains from the logistics standpoint (Bowersox & Gloss, 1996; Vorobey et al., 2009; Lambert, 2004; Gukalyuk, 2015). The analysis of specialized literature indicates the importance of restructuring of the logistic chains under the conditions of globalization, that is, the creation of information and innovation platforms in the process of logistics management. Indeed, with comprehensive consideration of logistics operations, completely new areas of activity are carried out, which contribute to creation of competitive advantages in the market.

In the study on the factors of sustainable European agri-food supply chains, Fischer, Hartmann, Reynolds and others (2009) prove the significance of quality orientation and traceability schemes. Moreover, supply chains are also affected by market conditions, industry and company-specific characteristics.

Today, it is important to improve supply chains taking into consideration the criteria of sustainability. The study performed by Koberg and Longoni (2019) demonstrates sustainable supply chain management and suggests that sustainability outcomes in supply chains should be improved. The value of their contribution is that they identified configurations and governance mechanisms to be the key elements of sustainable supply chain management in global supply chains, synthesizing their links to sustainability outcomes.

Mollenkopf, Ozanne and Stolze (2021) study the role of the supply chain ecosystem in ensuring the health and safety of employees and customers as a well-being outcome during the COVID-19 pandemic through the lens of transformative service research. The pandemic disturbed global supply chains, whereas the war in Ukraine is destroying them. The prolonged war is the largest challenge for supply chains today. The war creates market barriers by impeding the movement of goods, in particular agricultural products. This produces even larger adverse effects for supply chains accompanied by price increases nearly every week, which has consequences for inflation. As a result, the majority of businesses and millions of consumers worldwide are suffering from newly created economic problems (Noble, 2022).

The aim of this article is to analyze major supply chains in crop production and to identify ‘bottlenecks’ that need to undergo prompt structural changes under the conditions of global epidemics and armed conflict.

Methodology

In order to analyze the formation of crop production supply chains, we worked through theoretical and practical issues of agricultural supply chains. The assessment of supply chains in crop production covers three periods: (i) the period prior to the COVID-19 pandemic; (ii) the period during the COVID-19 pandemic of 2020-2021; (iii) and the period after the Russian invasion into Ukraine began in 2022.

The production of vegetable oil in Ukraine is extremely important, taking into account its provision to the domestic market and exports to the world market. At the same time, only 10% of sunflower oil is consumed domestically, whereas 90% of it is exported. In view of this, the authors carried out the correlation analyses of the relationship between Ukrainian exports of sunflower oil and production of sunflower seeds in Ukraine, as well as of the relationship between Ukrainian exports of sunflower oil and production of sunflower oil in Ukraine. At that, two conditions had to be satisfied: (1) the more raw materials are produced in Ukraine, the higher is Ukraine's export capacity; (2) the more sunflower oil is produced in Ukraine, the larger can be its exports.

The data were sourced from the State Statistics Service of Ukraine (2022) and the APK-inform (2022). In order to analyze the above-mentioned relationships, we used the data on Ukrainian exports of sunflower oil, Ukrainian production of sunflower seeds and Ukrainian production of sunflower oil for the period from 2000 to 2021 (Figure 1).

Figure 1 points to the existence of obvious relationships among the factors under study. Thus, regression analysis should help to determine the strength of these relationships.

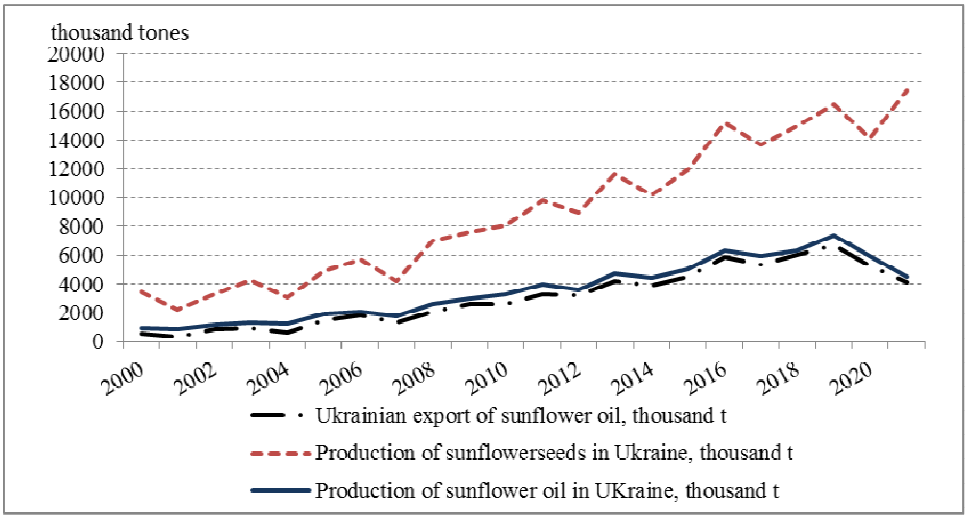
Research Results

The formation of supply chains in crop production starts at the level of agricultural producers at the point when they use resources for production, collection and preparation for storage of the products. The next tier in the analyzed chains is consumption. Traditionally, the main distribution channels for crop products include processing enterprises, domestic market sales, and exports.

In Ukraine, crops are cultivated by agricultural enterprises and by individual farms (household farms). The structure of production for major agricultural crops varied by category of farms (Table 1). Thus, agricultural enterprises held a significant share in the total production of grains and leguminous crops, sugar beets and sunflowers; whereas household farms were mosly engaged in the growing of potatoes, vegetables, fruits, and berries.

Figure 1

The dynamics of Ukrainian exports of sunflower oil, Ukrainian production of sunflower seeds and Ukrainian production of sunflower oil over the period from 2000 to 2021



Source: designed using the data of State Statistics Service of Ukraine (2022).

Table 1

The structure of crop production by farmer category (in per cent of total)

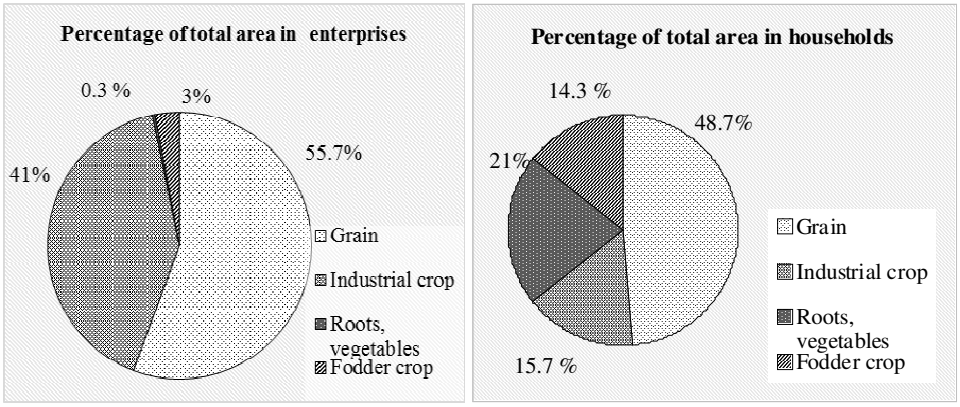
Type of crops	2000		2018	
	Agricultural enterprises	Household farms	Agricultural enterprises	Household farms
Grains and leguminous crops	81.6	18.4	80.1	19.9
Sugar beets	87.8	12.2	95.3	4.7
Sunflowers	87.5	12.5	86.1	13.9
Potatoes	1.4	98.6	1.9	98.1
Vegetables	16.9	83.1	14.4	85.6
Fruits and berries	18.2	81.8	21.6	78.4

Source: designed using the data of State Statistics Service of Ukraine (2019).

In 2018, the largest share in the stucture of sown area of agricultural enterprises was occupied by grain crops (55%), followed by industrial crops (41%), fodder crops (0.3%) and vegetable crops (3%). For household farms, the structure of cultivated areas was different: Grain crops accounted for 48.7% of the sown area, followed by technical crops (15.7%), fodder crops (14.3%) and vegetables (21%).

Figure 2

The structure of the sown area under agricultural crops in 2018



Source: designed using the data of State Statistics Service of Ukraine (2019).

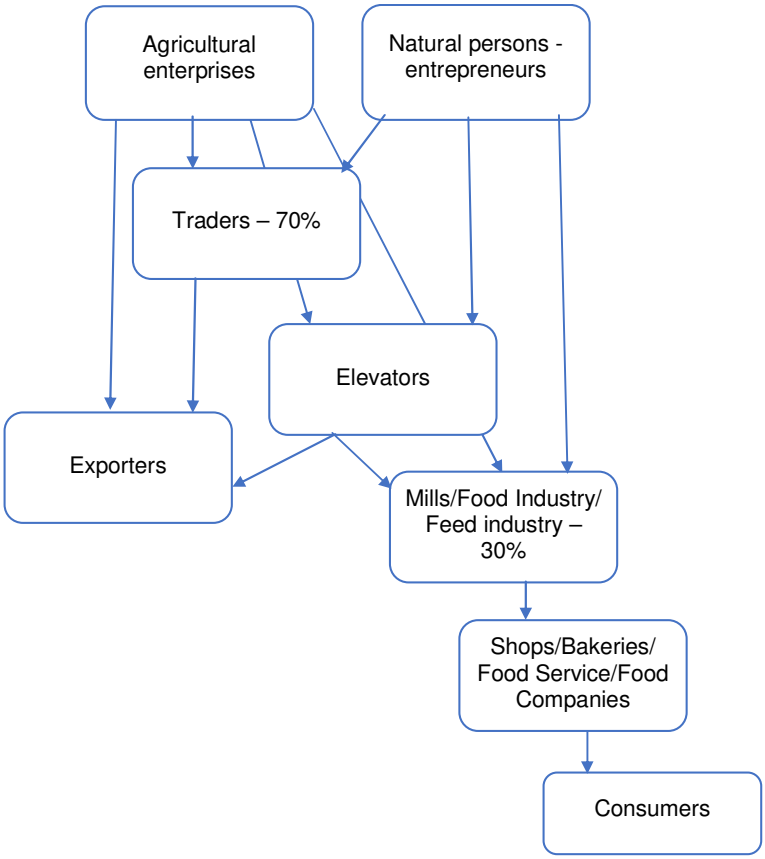
Our research shows that over the recent years (before the COVID-19 and during the pandemic), Ukraine has been gradually increasing its supply of grains. In the supply chain of grain crops, the main producers are agricultural enterprises, which use high-intensity cultivation technologies (Figure 3).

The produced grains were mostly (up to 70%) purchased by traders, whereas the rest was consumed domestically, which satisfied the demand from the food and the animal feed industries.

It was due to low capacity of the domestic market that grain exports have been on the rise for the last couple of years. According to global exporter rankings, in the 2019/2020 marketing year Ukraine has become one of the world's leading suppliers of grains by volume of total exports (ranking 2nd in barley exports and 5th in wheat exports). Ukraine's share was stable at 13% of the world's total production of corn, 3.7% of the world's production of wheat, 5.6% of the world's total production of barley and 2% of the world's total production of oats.

Figure 3

Main participants in the supply chains of grain crops in Ukraine

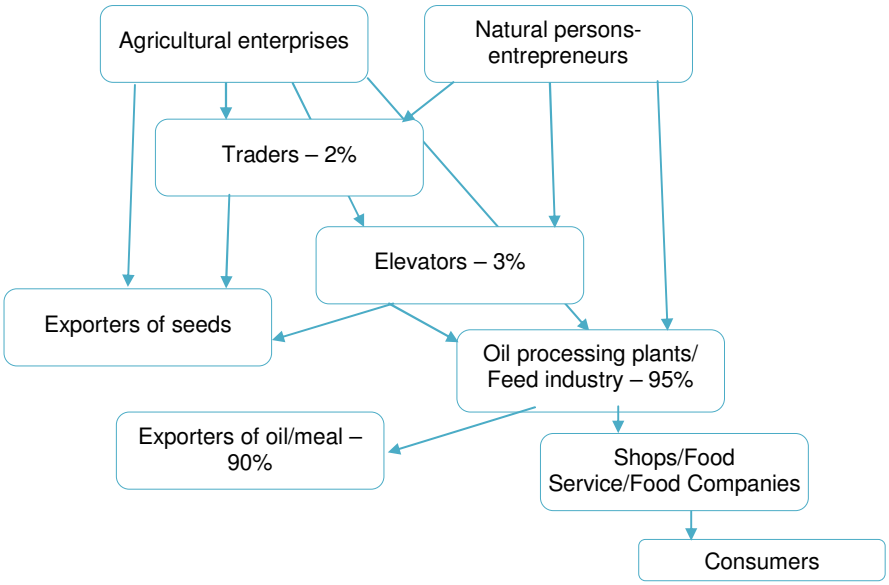


The demand and supply for oilseeds during 2018-2021 were for the most part in balance. The supply of sunflower seeds was dependent on the volume of their production; the demand for them was determined by the level of their consumption by Ukrainian processing enterprises (Figure 4).

It is worth noting that the observed demand for sunflower seeds from oil and fat processing enterprises was stable. According to results of the 2019/2020 marketing year, they processed more than 95% of seed crop, which equated to 7 million tons of sunflower oil production, of which 6.4 million tons (90%) were exported (Kuts & Makarchuk, 2021).

Figure 4

Main participants in the supply chains of sunflower seeds in Ukraine



Thus, during the periods before and during the COVID-19 pandemic, the supply chains of sunflower seeds in Ukraine were not disrupted. In what concerns the supply of sunflower oil, we carried out a regression analysis of the relationships between the exports of sunflower oil and the production of sunflower seeds and the production of oil.

In our study, we developed two simple regression equations to describe the above-mentioned relationships. The first regression equation describes the dependency between sunflower oil exports from Ukraine (SOil_export) and production of sunflower seeds in Ukraine (SSeeds_production). In this case, the results show that a 1-thousand-ton increase in the production of sunflower seeds leads to an increase in sunflower oil exports by 0.39 thousand tons. The results of this regression analysis suggest a strong relationship between these two factors because the multiple correlation coefficient, *R,* equals 0.96. The model is significant, as confirmed by the lower than 0.05 *p* value for parameter a_1.

Table 2

Results of the regression analysis for the main factors that affect Ukraine's sunflower oil exports

Specification	Regression equation: SOil_export= -428.8+0.39*SSeeds_production	Regression equation: SO_export= -385.35+0.98*Soil_production
R	0.96	0.99
R^2	0.91	0.99
t value (for parameter a_1)	14.58	64.36
p value (for parameter a_1)	0.00	0.00

In the second regression equation, parameter a_1 was equal to 0.98, which means that a 1-thousand-ton increase in the production of sunflower oil will lead to an increase in sunflower oil exports by 0.98 thousand tons. As it was mentioned previously, 90% of Ukraine's sunflower oil is exported. Thus, the higher is the domestic production of sunflower oil, the more of it will be exported. The relationship between the researched factors is strong because the multiple correlation coefficient, *R*, is 0.99. The model is significant because *p* value is lower than 0.05.

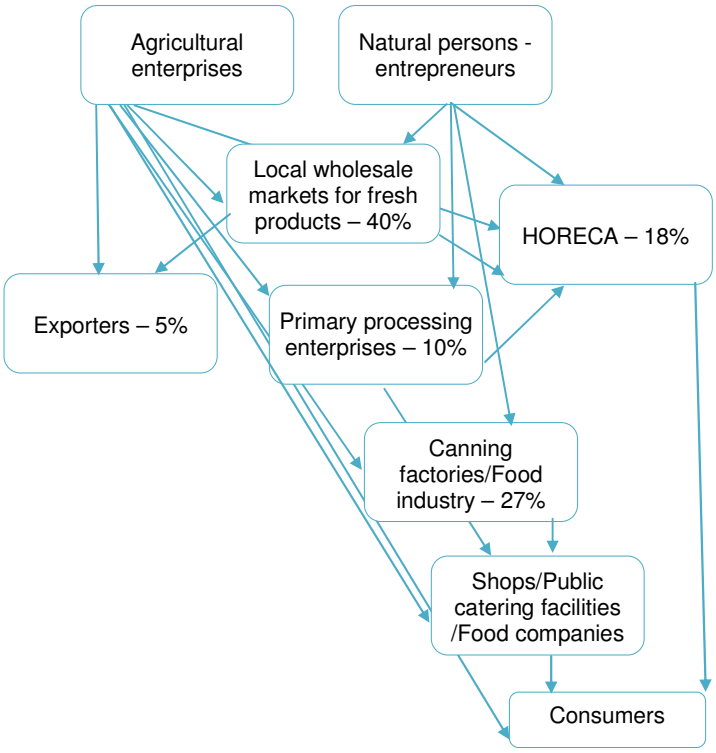
Therefore, it can be concluded that grain and oilseed supply chains remained relatively stable. They were among those supply chains that were least affected by the COVID-19 pandemic.

A quite different situation is observed in the supply chains for vegetables, which is brought by the diversity and fragmentation of their distribution channels (Figure 5).

Our research shows that of the total vegetable products sold, 40% were sold through local wholesale markets, 18% were sold to restaurants and public catering establishments (aka HORECA), 10% were supplied to primary processing enterprises, and 27% were sold to industrial enterprises as raw inputs. In these chains, production is mainly performed by small producers, which do not have guaranteed channels of distribution, which negatively affects the prices and quality of their products. This explains the vulnerability of the vegetable sector during the COVID-19 pandemic: The businesses were suffering losses due to disruption of distribution channels, reduced demand, as well as problems with supply of fertilizers, seed purchases, increased prices for raw materials, and labour shortages. As an adaptation strategy, some companies switched to direct deliveries of orders to consumers.

Figure 5

Main participants in the vegetable supply chains of Ukraine



Faced with new challenges, some producers decided that they would switch to food industry in the future. The diversification of distribution channels increases the adaptive capacity of producers and reduces the risk of adverse effects arising from the loss of any one of them. Providing practical legal advice to agricultural producers and enhancing their competitiveness through development of advisory services and business associations are the issues that retain their urgency.

In February 2022, the Russia's war on Ukraine spread from the Eastern part of the country over to the rest of its territory. The war gave rise to new problems in the business environment. The first group of problems is related to a partial loss of territories with strong economic potential in the East and South of Ukraine (physical destruction of infrastructure and housing; outflow of capital and

working population, general increase in business and investment risks). The second group of problems results from the loss of Ukraine's traditional sales markets, destruction of production facilities and transport infrastructure; as well as the loss of inter-industry and material and technical connections in the regional and foreign economic space.

All these causes have adverse effects on the formation of all supply chains of major crops. In Ukraine, 90% of all exports were realized through the ports of the Black Sea and the Sea of Azov. Now, agricultural producers have to develop new supply chains across Europe. Meanwhile, rail transport is the only viable option, even though it is capable of transporting only 0.6 million tons of exports per month (compared to 5-6 million tons prior to the war). Investments in transport infrastructure, however, could increase this volume.

Logistics operations allow enterprises to achieve market growth, significant economies of scale and increased profitability. Under the current difficult conditions of in Ukraine, the role of material and technical support is gaining in importance. Implementation of the restructuring of supply chains will contribute to discovery of all accessible market opportunities and improvement of the decision-making system.

Conclusions

Proceeding from the results of our study, we can conclude that the changes in the structure of crop production that have taken place during the last two decades in Ukraine are insignificant, in terms of both the assortment and the producer categories.

The supply chains of crop products (grain crops, sunflower crops and vegetables) in Ukraine are quite long. The composition of the main participants in these supply chains adjusts in line with product characteristics, its level of processing and distribution channels. The supply chains of crop products reflect the priority channels of their distribution.

During the period prior to the COVID-19 pandemic, Ukrainian crop production had stable chains of supply to domestic and foreign markets. A clear system of distribution channels, developed supply logistics and the possibility of using sea ports for international trade were major competitive advantages of the grain and sunflower supply chains.

In order to assess the stability of sunflower seeds supply chains, we carried out a regression analysis. The analysis of the reliance of Ukraine's sunflower oil exports on the production of sunflower seeds in Ukraine showed that a 1-thousand-ton increase in production of sunflower seeds leads to an increase in

exports of sunflower oil by 0.39 thousand tons. The analysis of the relationship between Ukraine's sunflower oil exports and domestic production of sunflower oil revealed that a 1-thousand-ton increase in sunflower oil production leads to an increase in sunflower oil exports by 0.98 thousand tons.

The influence of the COVID-19 pandemic is felt at all levels of supply chains. During the period from 2020 to 2022, supply chains were negatively affected primarily by the non-economic factors of external environment (the impact of the COVID-19 pandemic and the negative consequences of the Russian war in 2022). As a consequence of shortages in land and labour resources and due to loss of distribution channels, the traditional supply chains of crop products were broken.

The Ukrainian producers are now forced to review the range of crops for growing, taking into account the possible new channels of distribution. It is important not only to ensure production, but also to preserve and sell the harvest. Further research is necessary to find wartime solutions to these problems.

References

Bowersox, D. J., & Closs, D. J. (1996). *Logistical management: The integrated supply chain process.* McGraw-Hill.

Fischer, C., Hartmann, M., Reynolds, N., Leat, P., Revoredo-Giha, C., Henchion, M., Albisu, L. M., & Gracia, A. (2009). Factors influencing contractual choice and sustainable relationships in European agri-food supply chains. *European Review of Agricultural Economics, 36*(4), 541–569.

Gukalyuk, A. (2015). Improvement of supply chains in the conditions of international business trends. [in Ukrainian]. *Economic analysis: Collection of scientific papers of TNEU, 21*(2), 48-54.

Koberg, E., & Longoni, A. (2019). A systematic review of sustainable supply chain management in global supply chains. *Journal of Cleaner Production, 207,* 1084-1098. https://doi.org/10.1016/j.jclepro.2018.10.033

Kuts, T., & Makarchuk, O. (2021). The economic efficiency of sunflower seed production in Ukraine: State and perspectives. *Scientific Papers Series: Management, Economic Engineering in Agriculture and Rural Development, 21*(1), 449-456.

Lambert, D. M. (2004). Supply chain management. In: D. M. Lambert (Ed.), *Supply chain management: Processes, partnerships, performance* (4th ed., pp. 1-22). Supply Chain Management Institute. https://www.researchgate.net/

publication/280493809_Supply_Chain_Management_Processes_Partnerships_Performance_Chapter_1_Supply_Chain_Management

Mollenkopf, D. A., Ozanne, L. K., & Stolze, H. J. (2021). A transformative supply chain response to COVID-19. *Journal of Service Management, 32*(2), 190-202. https://doi.org/10.1108/JOSM-05-2020-0143

Noble, P. (2022). The Ukraine-Russia war's impact on the supply chain: Why MRO optimization is a top priority. *Forbes.* https://www.forbes.com/sites/paulnoble/2022/05/12/the-ukraine-russia-wars-impact-on-the-supply-chain-why-mro-optimization-is-a-top-priority/

State Statistics Service of Ukraine. (2022). http://www.ukrstat.gov.ua.

Vorobey, V., Danilyuk, A., & Zhurovska, I. (2009). *Responsible management of supply chains.* [in Ukrainian]. United Nations Office in Ukraine. https://ppv.net.ua/uploads/work_attachments/Responsible_Supply_Chain__UA_.pdf

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