



XXXI International Scientific Conference
Strategic Management
 and Decision Support Systems
 in Strategic Management
Sm2026

Subotica (Serbia), May 18, 2026

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Participation (direct/virtual):

direct

JEL:

THE FOOD SUPPLY CHAINS DISRUPTIONS AND GLOBAL INSTABILITY: A THEORETICAL APPROACH

Abstract: The food supply chain is a network of interconnected entities that aims to deliver sufficient and healthy agri-food products to end consumers. In recent years different factors such as global health crises, climate change, extreme weather events, and geopolitical conflicts has significantly affected the functioning of food supply chains. Given that food represents a basic need and a key factor of economic and social stability, understanding these dynamics is of crucial importance. Bearing this in mind, this paper aims to analyze, based on a review of the relevant literature, the impact various shocks have on the functioning of food supply chains, as well as their potential effects on global instability. Special attention is given to the identification of key sources of disruption and the mechanisms through which these disturbances are transmitted across different stages of the supply chain, with the objective of highlighting the main drivers of instability and their implications in the recent period.

Lanac snabdevanja hranom je mreža međusobno povezanih entiteta koja ima za cilj da isporuči dovoljne i zdrave poljoprivredno-prehrambene proizvode krajnjim potrošačima. Poslednjih godina različiti faktori poput globalnih zdravstvenih kriza, klimatskih promena, ekstremnih vremenskih prilika i geopolitičkih sukoba značajno su uticali na funkcionisanje lanaca snabdevanja hranom. S obzirom na to da hrana predstavlja osnovnu egzistencijalnu potrebu i ključni faktor ekonomske i društvene stabilnosti, razumevanje ove dinamike je od ključne važnosti. Imajući ovo u vidu, ovaj rad ima za cilj da, na osnovu pregleda relevantne literature, analizira uticaj različitih šokova na funkcionisanje lanaca snabdevanja hranom, kao i njihove potencijalne efekte na globalnu nestabilnost. Posebna pažnja je posvećena identifikaciji ključnih izvora poremećaja i mehanizama putem kojih se ovi poremećaji prenose kroz različite faze lanca snabdevanja, sa ciljem da se istaknu glavni pokretači nestabilnosti i njihove implikacije u skorijem periodu.

Keywords: food chain, supply, disruption, shock

1. INTRODUCTION

Food supply chains represent a complex system of interconnected participants whose main goal is to provide a sufficient amount of health-safe products to end consumers. They include all stages, from agricultural production, through processing, storage and transport, to wholesale, retail and final consumption (Jeremić, Matkovski & Zekić, 2024). In these chains, millions of agricultural producers are connected to a large number of consumers through a relatively small number of intermediaries (Deconinck et al., 2023). Given the large number of participants of different sizes, as well as the presence of public and private sectors, food supply chains are characterized by a high degree of

complexity and specific decision-making processes at all stages (Rojas-Reyes, Rivera-Cadavid, & Peña-Orozco, 2024). They can also take different forms, from traditional to modern, as well as local or global chains that span multiple countries.

Food supply chains have always been subject to various disruptions, or shocks, such as extreme weather conditions, wars, conflicts and pandemics, which also contribute significantly to global instability. Disruptions in supply chains can be defined as external events that are difficult to predict and control, which affect the functioning of the system by reducing the efficiency of production, processing and distribution (Rojas-Reyes, Rivera-Cadavid, & Peña-Orozco, 2024). The specific features of agricultural production, such as the dependence on natural resources such as land, water and climate, make this sector particularly sensitive to various shocks. Also, short-term inelasticity of supply, labor-intensive work processes, and increasing concentration in the food supply chain further exacerbate vulnerability to shocks. At the same time, due to the increasingly pronounced interdependence between sectors of the supply chain, the negative effects that arise in one segment of the chain are transmitted to others, both upstream and downstream. The negative effects of shocks generated in any segment of the food supply chain can also spill over into other related sectors and the economy as a whole with very negative consequences for employment, income and growth. Likewise, disruptions in other sectors, such as energy and finance, can also have a significant impact on the functioning of food supply chains. With the development of global supply chains, shocks within the food supply chains are increasingly transmitted across national borders, further contributing to global instability (FAO, 2025). In modern conditions, shocks, such as the COVID-19 pandemic, the war in Ukraine (Deconinck et al., 2023) and conflicts in the Middle East (FAO, 2026), together with the increasingly pronounced effects of climate change, further emphasize the importance of studying this issue.

Bearing in mind the above, the aim of this paper is to analyze, based on a review of the relevant literature, the impact of shocks on the functioning of the food supply chains and their contribution to global instability, with a special focus on the identification of key sources of disruption and mechanisms of their transmission through the various stages of the supply chain. The paper tries to point out the main sources of instability in the previous time period, and to look at their impact on the functioning of the supply chain. The structure of the paper is organized into four thematic units. After the introductory considerations and short presentation of the methodological framework of the research, the third part of the paper discusses the concept and types of shocks, i.e. disruptions that complicate the functioning of the food supply chain. Below is an overview of the literature that deals with analyzing the key sources of instability in the previous period. The last segment of the paper refers to concluding considerations.

2. RESEARCH METHODOLOGY

The literature review on disruptions in food supply chains and the selection of references were mainly based on the Scopus database. The analyzed literature includes papers published in English, including scientific articles, review papers, papers from conferences, as well as reports of relevant international organizations (FAO, OECD). When selecting sources, special attention was paid to their relevance to the subject of the research, with a focus on papers that analyze contemporary global disruptions and their implications for food supply chains.

3. DISRUPTIONS IN THE FOOD SUPPLY CHAIN: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Global food supply chains are characterized by a high degree of complexity, which significantly complicates their effective management. This complexity stems from the fact that the production, processing and distribution of food products include a large number of interrelated actors, who jointly participate in the process of meeting the needs of end consumers. Such systems, in which the interdependence of a large number of different actors as well as intersectoral connections and influences is expressed, are particularly sensitive to disruptions (Jeremić et al. 2024; Haessner, Haessner, & McMurtrey, 2024). More precisely, changes or dysfunctions in one segment of the chain can cause the so-called domino effect, generating chain reactions that reflect on the functioning of the entire system (Haessner, Haessner, & McMurtrey, 2024).

3.1. Concept and types of disruptions in the food supply chain

Disruptions in food supply chains are defined as external events that are difficult to predict and control, and which greatly affect the efficiency of the food supply chains. These disruptions can affect all segments of the food supply chain from production to consumption, thereby challenging food security and food safety. Additional complexity is represented by the very nature of food products, whose characteristics such as perishability, nutritional value and short shelf life increase the sensitivity of the supply chain to disruptions. Food supply chains are exposed to a wide range of disruptions that can potentially generate shocks of varying intensity, from minor disruptions that require limited adjustments, to disruptions that lead to a complete interruption of activities and disruption of connections between participants, thereby questioning the survival and functionality of the system as a whole. In this context, it is important

to distinguish shocks from stresses, and while shocks represent sudden and intense disturbances, stresses manifest themselves as long-term and cumulative pressures. However, both can significantly influence the stability of the supply chains. There is no single classification of these disorders in the literature, i.e. of shocks. For example, Rojas-Reyes, Rivera-Cadavid, & Peña-Orozco (2024) classify disorders according to origin into two categories: natural or man made origin. On the other hand, Deconinck et al., (2023) offers a more detailed typology and classifies disorders into five different categories, namely: extreme events, pest and animal diseases, food safety shocks, socio-economic systems and trade restrictions. According to FAO (2025), the most commonly accepted approach is the division of these shocks into two categories, namely natural or man-made (Table 1), with the possibility of their mutual interaction. *Natural hazards* arise from natural processes and phenomena and can be biological, geophysical, climatological, hydrological and meteorological. Biological hazards are of organic origin and spread by biological vectors, while geophysical hazards include earthquakes, tsunamis, volcanic activity and landslides. Climatological, hydrological and meteorological hazards are associated with extreme weather conditions and include droughts, floods, storms, typhoons and hurricanes. With these types of disturbances, the initial impact is seen mainly on agricultural production, where they can lead to the destruction of crops, loss of livestock, damage to infrastructure and reduced productivity. The consequences are then transmitted throughout the food supply chain, affecting its stability and efficiency. According to Deconinck et al., (2023), droughts represent one of the most common climatic disturbances and refer to a long-term lack of atmospheric, surface or underground water, which directly affects crop yields and livestock production. Their impact is primarily manifested at the producer level, but it can have wider consequences when it affects significant production regions, especially key areas for grain cultivation. In such cases, there is disruption in local and global food supply chains, which is further reflected in rising food prices and jeopardizing food security. The global impact of drought is greater if it affects a major growing region. Other extreme weather events and natural disasters, such as major storms or earthquakes, can have similar effects, leading to a sharp reduction in local production and disrupting the functioning of supply chains at the national and international level.

On the other hand, *man-made hazards* arise as a consequence of human activities and choices and include armed conflicts, changes in economic policies, financial crises, as well as technological hazards such as pollution, nuclear incidents, bioterrorism and cyber attacks. In practice, these dangers often occur simultaneously or are interconnected, whereby one disorder can initiate or intensify another. It is particularly significant that human activities can additionally intensify the consequences of natural disasters, which is why the border between natural and man-made hazards is often not clearly defined.

This interconnectedness is particularly evident in contemporary global crises, where climate change, conflicts and limited resources operate simultaneously. For example, countries often respond to rising food prices by introducing trade measures. Export restrictions were used during the food crises of 2006–2008 and 2010–2011 year, as well as during the COVID-19 pandemic and after the outbreak of the war in Ukraine. On the other hand, import restrictions such as tariffs, quotas and sanitary and phytosanitary standards can be applied to protect domestic production or because of food safety concerns, but also as part of a broader trade or political strategy. (Deconinck et al., 2023)

Table 1:Food supply chain hazards

Natural hazards
Biological:
• Plant pests; • Transboundary animal diseases; • Zoonoses; • Viruses; • Epidemics.
Geophysical:
• Earthquakes; • Landslides; • Volcanic activity; • Tsunamis.
Climatological, hydrological i meteorological:
• Droughts; • Extreme temperatures; • Floods; • Storms;

- Typhoons;
- Hurricanes;
- Wildfires.

Human induced hazards

- Conflict;
- Trade embargos;
- Financial crises;
- Nuclear events;
- Industrial pollution;
- Bioterrorism...

Source: According to, FAO (p.6, 2025).

In the following section of the paper, the focus is on the analysis of shocks that significantly affected the functioning of food supply chains in the previous period. Special attention was paid to disorders that had broad, long-term and systemic consequences. In this context, special attention is focused on key global shocks in the recent period, primarily the pandemic caused by the COVID-19 virus, the war in Ukraine and the current conflicts in the Middle East, which have significantly disrupted the stability and functioning of modern food supply chains, and contributed to global instability.

3.2. A literature review on disruptions in the food supply chain

Risks of disruption and uncertainty in food supply chains are continuously increasing, with these systems being among the most vulnerable to external shocks. Various hazards can disrupt the functioning of both local and global food systems, and their intensity and frequency are expected to increase further in the future. The dynamic and globalized nature of the modern world has significantly increased the complexity and interdependence of these chains, making them more susceptible to disruption. At the same time, the growth of the world's population and the increasing demand for food create additional pressure on their long-term sustainability (Hobbs & Hadachek, 2024). The sensitivity of food supply chains to different sources of shocks has become particularly evident in recent years, due to a series of crises that have shaken the global food system, including the COVID-19 pandemic, the emergence of plant and animal diseases, as well as geopolitical conflicts in Ukraine and the Middle East.

In modern conditions, the impact of climate change and increasing pressure on natural resources further intensify the exposure of food supply chains to various stresses and shocks. Although the spectrum of dangers has not changed significantly, the increase in the probability and frequency of their manifestation is evident. Of particular note is the increase in the frequency of extreme weather events such as droughts, floods and storms which, according to available data, has increased up to four times in the last fifty years. In contrast, the frequency of geophysical phenomena, such as earthquakes, has remained relatively stable. At the same time, there has been a significant increase in plant pests and diseases, despite progress in early warning and control systems. A similar trend is present in cross-border animal diseases, especially zoonoses, which further increases the risks in the agricultural and food sector. It should be borne in mind that the available statistics often underestimate the actual extent of damage, since they include only disturbances of greater intensity, while economic losses are most often estimated solely on the basis of deviations of agricultural production from expected trends. This ignores the fact that agricultural production is only one segment of the supply chain, and that the total effects of the disruption go far beyond this level. (FAO, 2025)

Climate change has a particularly pronounced impact on global food production. Rising temperatures and changes in precipitation patterns affect plant development, shorten growing seasons, and lead to reduced yields, especially under conditions of extreme weather events such as droughts, floods, heat waves, and storms. In addition to the direct effects on production, these conditions cause damage to transport, logistics, energy and communication infrastructure, further hampering the functioning of supply chains and reducing the efficiency of food distribution. Finally, climate change affects the stability of the global food market, causing fluctuations in supply and prices. In response to these challenges, some countries are resorting to measures such as export restrictions, agricultural subsidies and other policies aimed at preserving domestic food security and price stability. (Jin, Liu, & Huang, 2025)

The pandemic caused by the COVID-19 virus was a global shock that simultaneously affected all segments of the food supply chains, from primary production, through processing and logistics, to demand itself. However, the intensity of the impact was not uniform, as different sectors and products were affected at different stages of the chain. In agricultural production, the key problem was bottlenecks in the availability of labor, especially seasonal ones. Mobility restrictions significantly reduced the supply of workers for sowing and harvesting, which particularly affected labor-intensive sectors such as fruit and vegetable production, while less labor-dependent sectors such as cereals and oilseeds were relatively more resilient. At the same time, the initial uncertainty regarding the supply of inputs, such as

pesticides, further increased concerns, although disruptions in the supply of fertilizers and energy were less pronounced. The food industry was also significantly affected, due to the implementation of social distancing measures, a reduction in the available workforce and temporary plant closures. In particular, the meat processing sector stood out, which due to its labor-intensive nature was more susceptible to disruptions, in contrast to the highly automated grain processing, which showed greater resilience. Transport and logistics faced additional challenges. While the transport of bulk cargo (such as grain) did not suffer significant disruptions, the biggest problems arose in air transport, due to a sudden decrease in passenger traffic, which normally provides a large part of the capacity for the transport of perishable goods. Disruptions in container and road transport were moderate, but they additionally contributed to slowing down the flow of goods. One of the most pronounced effects of the pandemic was a sharp turn in the structure of demand. The closure of restaurants and catering facilities led to a decline in consumption of food outside the household, while at the same time retail demand for food for home use, especially for packaged and frozen products, increased significantly. This change required rapid adaptation of supply chains, which had to redirect goods flows and change logistics patterns. In that process, there was an imbalance between supply and demand: interruptions in processing, especially meat, created situations in which producers had surpluses, while consumers were simultaneously faced with shortages of certain products. In the case of certain products, such as raw materials intended for catering, there was a temporary surplus of supply due to reduced demand. At the same time, in the initial stages of the pandemic, empty retail shelves were also recorded, which was a consequence of the sudden increase in demand and the time delay in adjusting the supply chains. (OECD, 2020; Rojas-Reyes, Rivera-Cadavid, & Peña-Orozco, 2024; Hobbs & Hadachek, 2024; Haessner, Haessner, & McMurtrey, 2024; FAO, 2025)

Approximately two and a half years after the outbreak of the COVID-19 pandemic, the global food supply system faced another significant shock, the war between Russia and Ukraine. This conflict further worsened the already damaged stability of food supply chains. Namely, Russia and Ukraine had a key role in the world market of agricultural products, especially when it comes to the export of wheat, corn, barley and sunflower products, while Russia was also one of the world's largest exporters of mineral fertilizers. The war had multiple negative effects along the entire supply chain. In Ukraine, the capacity for soil cultivation and crop harvesting has been significantly reduced, due to limited access to agricultural land and disruptions in production activities. At the same time, there were serious problems in food processing and storage. Disruptions in logistics were especially pronounced, since port closures and export restrictions made it difficult or impossible to transport agricultural products to international markets. An additional problem is the destruction of the transport and logistics infrastructure, which further reduced the efficiency of food distribution. Given Ukraine's importance as one of the leading producers of key grains and oilseeds, these disruptions spilled over into the international market, negatively affecting food supplies, especially in European countries that were heavily reliant on imports from the region. (Haessner, Haessner, & McMurtrey, 2024) This supply shock came at a time when global food demand was recovering after the pandemic, while already reduced supplies due to bad weather conditions further worsened the situation. As a result, there was a sharp rise in food and input prices, which slowed the recovery of agricultural production and increased inflationary pressures at the global level. (FAO, 2026)

In contrast, contemporary conflicts in the Middle East have a different economic dynamic. As this region is not a significant exporter of basic agricultural products, the global food supply is not directly affected. However, given that the countries of the region represent important net importers of food, conflicts and instability lead to a decrease in demand on the global market. This difference in the nature of shocks also implies different economic consequences. While the war in Ukraine has caused a supply crisis and increased prices, disruptions in the Middle East may lead to problems of placement and surpluses in the market, while at the same time high production costs. At the center of this crisis is the Strait of Hormuz, which represents one of the most important waterways for international trade. A significant part of the world's trade in energy and agricultural inputs, including oil, liquid natural gas and fertilizers, passes through this narrow corridor. Any disruption in this region has immediate consequences for global supply chains, particularly through rising energy and production costs. In this context, unlike the war in Ukraine, which primarily caused a shock on the food supply side, the instability in the Gulf region acts more indirectly, but equally strongly through increasing the costs of key inputs. Rising fuel and fertilizer prices put an additional burden on agricultural production, reduce yields and contribute to rising food prices at the global level. These effects particularly affect countries that are already facing high levels of food insecurity. (FAO, 2026)

CONCLUSION

Disruptions in food supply chains are complex and difficult to predict events that can threaten the functioning of the entire system, from production to consumption. Their impact is further enhanced by the specific characteristics of food, which makes these chains particularly sensitive to shocks and long-term stresses. Modern risks most often arise from a combination of natural and anthropogenic factors, the effects of which intertwine and intensify. Understanding their mutual differences and similarities is of key importance for the application of existing knowledge and experience in order to identify effective responses, strengthen the robustness of the system and enable its faster recovery. Therefore, improving risk management is key to ensuring a stable and sustainable food supply. Global food supply chains in recent years have been faced with a series of consecutive and interconnected shocks that have significantly undermined their

stability and functionality. The COVID-19 pandemic represented an initial global disruption that simultaneously affected all stages of the supply chain, from production to consumption, primarily through disruptions in labor availability, logistics and sudden changes in the demand structure. Although supply chains adapted relatively quickly to the new conditions, the recovery remained fragile and uneven. In such a context, the outbreak of war between Russia and Ukraine further deepened the existing instability and increased the level of systemic risk. Unlike the pandemic, which predominantly acted through disruptions in the functioning of the system, this conflict directly affected the key sources of the global supply of food and agricultural inputs. Given the importance of Russia and Ukraine as leading exporters of grains, oilseeds and fertilizers, disruptions in production, export and logistics in this region had strong repercussions on the global food market. The cumulative effects of these two shocks are reflected in the decrease in the availability of certain food products, the increase in production costs (especially due to the increase in energy and fertilizer prices), as well as the increased volatility of prices on the world market. Additionally, export restrictions, infrastructure damage and reduced production capacity contributed to deepening imbalances between supply and demand. On the other hand conflict in the Middle East had different dynamic. Unlike the war in Ukraine, The Middle East conflict caused the problems of product placement and surpluses, and increased the production costs. This sequence of crises clearly indicates the high vulnerability of food supply chains to external shocks, but also the need to strengthen their resilience through the diversification of supply sources, the improvement of logistics capacities and the development of more effective risk management mechanisms.

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