

Navigating geopolitical risks: Implications for global supply chain management



Dmytro Rasshyvalov^a   | Yevhenii Portnoi^b  | Tetiana Sigaieva^c  | Oleksandr Alboshchii^d  |
Oleksandr Rozumnyi^e 

^aDepartment of International Business, Educational and Scientific Institute of International Relations, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine.

^bInterregional Academy of personnel management, Kyiv, Ukraine.

^cLogistics and Innovation Department, Management and Marketing Faculty, Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine.

^dDepartment of Logistics of Units, National Academy of the National Guard of Ukraine, Kharkiv, Ukraine.

^eDepartment of Entrepreneurship and Trade, West Ukrainian National University, Ternopil, Ukraine.

Abstract In today's changing world, understanding the impact of geopolitical risks on global supply chains is key to ensuring their efficiency and sustainability. Geopolitical events of recent years in the form of international conflicts, political changes, European economic sanctions and even natural disasters have a significant impact on global transport networks, causing various challenges and obstacles. The purpose of the article is to analyze the impact of such geopolitical risks on global supply chains, identify the main problems faced by companies, and develop strategies to overcome them. The article highlights the results of a complex study, which includes the analysis of academic sources, international reports, economic indicators, technological trends and regional features. It found that disruptions in supply chains due to geopolitical risks can have serious consequences, from increased costs and delivery delays to production shutdowns. The study points to the need to implement flexible and adaptive management strategies for intercontinental logistics systems that allow a quick response to changes in the geopolitical space. The key area of research is effective management of global supply chains in conditions of geopolitical uncertainty, which requires the integration of various approaches and technologies. The obtained results provide a valuable tool for strategic planning and decision-making in the field of transnational logistics restructuring, helping commercial companies to prepare and adapt to potential geopolitical changes.

Keywords: geopolitical risks, international logistics, economic sanctions, transport systems, sustainability of supply, transnational logistics

1. Introduction

In today's globalized world, where supply chains cross borders of countries and continents, they are increasingly vulnerable to geopolitical risks. The impact of such challenges on global supply chains is a key issue that requires deep understanding and analysis. Geopolitical events, during recent international conflicts, the implementation of economic sanctions, political changes in Europe and even natural disasters will have unpredictable consequences for transnational transport systems, affecting the stability of supply and the efficiency of business operations. Existing trends require companies to be flexible and adaptable, able to quickly respond to changes in the global economic space. Modern logistics complexes are tiered and multifaceted structures that include physical flows of goods, informational, financial and social factors. Understanding how geopolitical changes affect each of these components is key to managing risk and ensuring the stability of international logistics. Disruptions in intercontinental logistics can have far-reaching consequences, from increased costs and delivery delays to complete disruption of production processes. It is necessary to focus attention on the importance of understanding the interrelationships and the impact of geopolitical events on global business. The transformation of geopolitical risks into international routes has short-term and long-term consequences. Short-term effects include immediate disruptions in supply and changes in pricing, long-term effects can change the geography and structure of international trade, prompting companies to review and adapt their strategies. Transnational leaders are implementing forecasting and planning technologies to minimize the impact of unforeseen events, analytics is seen as a technological means to increase the resilience and flexibility of supply chains. The study of the problem requires the involvement of knowledge from the field of geopolitics, international relations, economics, risk management, and technology. Understanding such



aspects plays a critical role in developing effective strategies for companies seeking to optimize their transportation systems in an ever-changing global economic environment.

Studying the influence of geopolitical risks on global supply chains is a relevant and important issue in the conditions of complex international relations and economic globalization. Research (Monge, 2023) indicates that geopolitical changes, especially military conflicts and international sanctions, have a direct impact on the stability of global supply chains, causing the need to restructure them and find alternative routes. The author (Bernards, 2022) emphasizes that political instability in key regions such as the Middle East or Southeast Asia can lead to significant logistical obstacles and increased transportation costs. According to (Free, 2021), economic sanctions, as a tool of geopolitical pressure, can have far-reaching consequences for international trade, forcing companies in Europe to review their business models and investment strategies. The researcher (Flouros, 2022) focuses on how technological innovations in the field of digitization and automation can help minimize the impact of geopolitical risks, ensuring greater flexibility and adaptability of transport systems. At the same time, as (Caldara, 2022) observes, technological progress may also introduce additional challenges in the need to strengthen cyber security protection and manage large volumes of data. The work (Alsagr, 2023) emphasizes the need to develop new risk management strategies that include diversification of supply sources and investments in business resilience to geopolitical changes. Analysis (Sohag, 2022) indicates a significant impact of climate change on global supply chains, particularly through increased risks of natural disasters and their impact on transport networks. The scientist (Bouri, 2022) pays attention to the regional aspects of the problem, showing how different geographical zones react differently to geopolitical changes and how this affects international trade. A study (Hertz, 2023) emphasizes the importance of international cooperation and the development of global standards to ensure greater transparency and efficiency in the management of transnational routes. In addition, (Dauvergne, 2022) emphasizes the need to consider environmental and social aspects in logistics management strategies, pointing to the growing role of sustainable development and corporate social responsibility in the global economy. Research (Um, 2021) indicates that technology companies that are able to respond quickly to changes in the geopolitical space have a competitive advantage through the ability to minimize supply interruptions and reduce costs. The author (Long, 2022) focuses on the analysis of the impact of trade wars between China and the United States, international sanctions, pointing to significant challenges for dependent countries associated with the need to reorient production capacities and search for new sales markets. According to the results of the study (Dutta, 2022), regulatory changes of liberalization and protectionism due to the strengthening of customs procedures and export-import standards have a significant impact on transport networks. Particular attention in the literature is given to the challenges faced by companies due to climate change and environmental risks. According to (Ghadge, 2021), climate change will affect global logistics and transportation of goods, especially in vulnerable regions where natural disasters occur more often. Analysis (Adra, 2023) highlights the need to integrate sustainable development into supply chain strategies, including the use of renewable energy sources, resource efficiency and minimization of environmental impact. The author (Będowska-Sójka, 2022) emphasizes the importance of the social responsibility of companies in the context of the growth of the logistics market and the observance of human rights. In addition, (Lerner, 2023) points out the importance of strategic planning and developing alternative scenarios through modeling so that companies can adapt to changes in the geopolitical environment and minimize potential losses. Considering the constant uncertainty and dynamics of the international environment, the research issues require constant monitoring and search for solutions for companies and the political sector for effective reorientation of production capacities.

The purpose of the study is to analyze the impact of geopolitical risks on global supply chains, identify the main challenges and determine strategies for their effective management. The problem is to reveal the short-term and long-term consequences of geopolitical changes for international trade and transport corridors. To achieve this goal, a comprehensive approach is used, which includes the analysis of scientific publications, reports of international organizations, economic data and real case studies. One of the promising areas of research is the study of the impact of technological innovations and the strengthening of international cooperation aimed at optimizing transnational logistics routes in difficult political and economic conditions. The main tasks are the definition and identification of key geopolitical risks, the analysis of the perspective of the development of influence on variable transport routes, and the development of recommendations to increase their stability and flexibility.

2. Materials and Methods

A thorough review of sources was conducted to provide an in-depth and comprehensive analysis of the impact of geopolitical risks on global supply chains. The basis of the research was academic works, official reports of governmental and international organizations, as well as analytical publications from leading economic institutes. Such an approach made it possible to provide a variety of perspectives and a depth of understanding of the issues under consideration. Particular attention was paid to current data on economic indicators, political changes, technological innovations, as well as modern challenges facing global supply chains. An important role in the research was played by the analysis of current news and reports from the world mass media. The method of content analysis made it possible to quickly respond to the latest events in world geopolitics and economy, to assess their impact on global supply chains. This approach was given to news related to trade wars, international conflicts, political reforms and other significant developments between the US and China. The

analysis of news sources helped to collect relevant information that is not always available in traditional academic and official reports. The article includes a detailed analysis of centralized and decentralized logistics systems in geographic regions, including North America, Europe, Asia Pacific, the Middle East, Africa, and Latin America. The research toolkit includes statistical analysis, modeling of economic scenarios, as well as the use of information systems for data collection and processing. The use of such tools has made it possible to effectively analyze large volumes of data, identify trends and patterns that affect global supply chains. Carrying out the appropriate structuring made it possible to assess the regional features of transport routes, their impact on international trade and the transformation of logistics. An important aspect was the identification of regional risks, including political instability, economic sanctions and natural disasters, which may affect global supply chains in the context of increased protectionist market policies. The research approach was based on a combination of several methods and tools, which allowed to obtain a multifaceted and deep understanding of the impact of geopolitical risks on global supply chains, which made it possible to assess the current state of logistics systems and identify potential risks and opportunities for their optimization in the future.

3. Results

Geopolitical risks include international conflicts, political instability, economic sanctions, and changes in government policies affecting the functioning of global supply chains. Political and economic risks can lead to disruptions in the flow of goods and services, increases in transportation costs, and changes in supply and demand in markets. Geopolitical tensions between major economic powers cause trade wars, which lead to the introduction of tariffs and other trade restrictions from the position of market protectionism. Such measures increase the cost of goods for consumers and require companies to review their supply chains, looking for alternative sources and markets. Geopolitical conflict zones encourage multinational companies to develop more flexible and sustainable strategies for managing supply systems, routes, in particular through the diversification of suppliers and back-up logistics options.

A good example of how to overcome geopolitical risks in supply chains is the situation in January 2024, when container freight rates increased sharply due to US and UK airstrikes in Yemen. The strikes were aimed at Iran-backed Houthi forces, which have been attacking shipping in the Red Sea. This has forced most container ships to avoid the Suez Canal, a major trade route that handles 12% of global trade. As a result, ships were forced to bypass the Cape of Good Hope in Africa, which significantly increased transit time and costs. The Shanghai Container Freight Index, which reflects container shipping rates from Chinese ports, has increased by 114% since mid-December 2023. Tariffs on routes to Europe and the US West Coast have also risen sharply. The change caused global shipping problems as major industry players faced rising costs and delays. The route change added about 10 days and \$1 million in fuel costs for each trip between Asia and Europe. Large importers such as Tesla, Volvo, and Ikea faced product shortages and delays. The overall reduction in available space for ships on key trade routes has raised transportation tariffs and surcharges, which will lead to higher prices for a wide range of goods around the world. To mitigate the repercussions of this circumstance, various enterprises have proficiently managed geopolitical risks by employing adaptive tactics. For example, some companies diversified their production bases in response to trade tensions to reduce the impact of tariffs and trade barriers. Others have used advanced analytics to predict and mitigate the effects of political instability in a supplier country (Meehan, 2024).

Instability on the European continent and increasing military conflicts limit foreign direct investment, which is important for the development of transport and logistics infrastructure. In turn, such circumstances complicate access to new markets and increase logistics costs. However, the American and Eastern regions use geopolitical threats as opportunities to attract investment, improving their infrastructure and creating more favorable conditions for international trade, restructuring the military and industrial complexes. On the positive side, global supply chains are shifting as companies seek more stable and efficient routes for their products. However, this process can also be associated with additional costs and complications, especially for small and medium-sized enterprises that have limited resources to adapt to these changes. Modern trends of the logistics market and features of the formation of supply chains are shown in Table 1.

Table 1 Characteristics of the global supply chain market.

Category	Details
Market size value in 2022	US \$28.9 Billion
Revenue forecast by 2027	US \$45.2 Billion
Growth Rate	CAGR of 9.4%
Forecast period	2022–2027
Segments covered	Supply Chain Management, Component (Hardware, Software, and Services), Deployment Mode, Organization Size, Vertical, and Region
Geographies covered	North America, Europe, Asia Pacific, Middle East and Africa, and Latin America
Companies covered	SAP (Germany), Oracle (US), Infor (US), Descartes (Canada), Manhattan Associates (US), IBM (US), Logility (US), Kinaxis (Canada), Blue Yonder (US), Körber (US), Coupa (US), Epicor (US), BluJay (US), OMP (Belgium), E2open

(US), JAGGAER (US), Zycus (US), GEP (US), Tive (US),

Source: Supply Chain Management (2022)

The supply chain management (SCM) software market is estimated to be worth \$28.9 billion in 2022, indicating its significant scope and role in today's business environment. The market is forecast to grow to \$45.2 billion by 2027 at a compound annual growth rate (CAGR) of 9.4%, reflecting the dynamic development of technology and increasing demand for innovative solutions in supply chain management (Levytska et al., 2022). The growth can be explained by several key factors, including the increasing complexity of supply chains, the need for their optimization and automation, as well as the growing need to integrate various business processes into a single management system. Market segmentation processes indicate aspects such as solution types (hardware, software, services), implementation modes, organization size, market verticals, and geographic location. Differentiation shows the wide range of needs of different types of businesses, from small to large, and the variety of industries where SCM systems can be applied. The available variety of offers on the market allows companies to choose optimal solutions that meet their unique requirements and the specifics of business processes. As an example, following the disruption caused by COVID-19, special approaches have been applied, but they are not always effective, even in developed economies (Sodhi et al., 2021) Supply chain redesign includes a wide range of solutions, such as organizational structure, sourcing, transportation, and more (Blessley & Mudambi, 2022). Changes in the configuration of the supply chain have a significant impact on productivity and risk resilience, and the growing complexity makes them more vulnerable. One of the proposed solutions is the regionalization of supply chains, involving the relocation of production facilities closer to markets. Also discussed is a shift away from the just-in-time management model in favor of higher inventory levels. However, researchers rarely consider the costs and timeframes of such initiatives, as well as the complications associated with moving complex supply chains (Bednarski et al., 2024).

Transportation systems provide coverage to major world regions such as North America, Europe, Asia Pacific, Middle East and Africa, and Latin America, underscoring the global nature of this market. Differences in regional economic development and differences in business models create unique challenges and opportunities for SCM solution providers. Companies mentioned in the study, such as SAP, Oracle, Infor, IBM and others, are important players in the logistics market, offering a variety of solutions that can meet the specific needs of varied geographic and sectoral segments. Commercial companies play a key role in shaping the future of the SCM market, offering innovative and effective solutions that help enterprises optimize their supply chains and increase the efficiency of business processes. However, the presence of geopolitical risks and problems complicate their activities, the main challenges that developed in 2023 and will continue in 2024 are depicted in Figure 1.

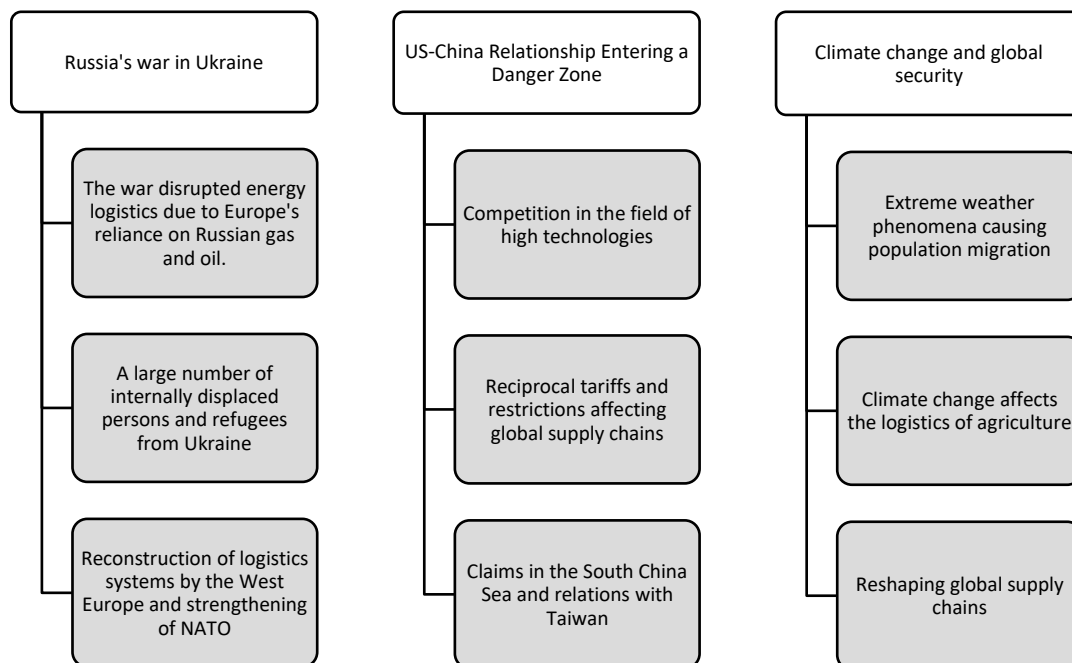


Figure 1 Geopolitical risks and their areas of influence on intercontinental transport systems.

Russia's war against Ukraine is having a significant impact on global supply chains, particularly in energy, agriculture and manufacturing. Russia as one of the world's largest exporters of oil and natural gas, and Ukraine as a significant producer of agricultural crops (especially wheat and corn), are critical to global markets. As a result of hostilities and sanctions imposed on Russia, the global energy market experienced fluctuations, which led to an increase in oil and gas prices. European

countries that have traditionally depended on Russian gas are looking for alternative energy sources, leading to changes in global energy supply chains. The blockade of Ukraine's ports and military actions on its territory led to a significant decrease in grain exports, which caused unrest in world food markets. The development of logistics trends is especially critical for countries that depend on imports of Ukrainian wheat and other grains. The increase in food prices and the threat of food security in a number of regions of the world are a direct consequence of these events. The war also negatively affects global logistics systems by increasing logistics and transportation costs, increasing supply problems for raw materials and components for various industries, including automotive and high-tech (Kotenko et al., 2020; Perevozova et al., 2023).

Technological confrontation and trade disputes between the US and China are significantly transforming current global supply chains. China is one of the world's major producers and exporters of goods, and any impediment to trade between these two economic giants has resonance around the world. The imposition of tariffs and restrictions by the US on Chinese goods, and corresponding countermeasures by China, complicate trade, increase the cost of goods and create uncertainty in the markets, especially in the fields of electronics and technology, where both countries are key players. The US is taking steps to reduce dependence on Chinese technology components and resources, particularly in the areas of metalworking and 5G technologies. As a result, such actions lead to disruption of existing logistics structures and active searches for new sources and supply channels, which can cause additional costs and disruptions in production. Political uncertainty, particularly in the US-China relationship on regional security, particularly in the South China Sea and relations with Taiwan, is also an important factor, adding an element of risk to global companies that depend on these markets.

Climate change affects global transportation systems by increasing the frequency and intensity of extreme weather events such as droughts, floods, hurricanes, and other natural disasters. Natural events can lead to disruptions in production, damage to infrastructure and vehicles that are important for the transportation of goods. Droughts in certain regions of the world can affect the production of agricultural crops, as a result of which the price of food products increases and their availability on the world market decreases. On the other hand, floods and hurricanes can damage manufacturing facilities, warehouses and logistics centers, resulting in supply delays and increased shipping costs. Floods and other extreme weather events can damage infrastructure such as roads, bridges and ports, which are critical to the efficient operation of transport systems and routes. Companies and governments must invest in the sustainability of supply chains by considering environmental risks and developing more environmentally sustainable practices.

Geopolitical challenges such as Russia's war against Ukraine, rising tensions between the US and China, and global climate change are having a significant impact on global supply chains. They not only cause immediate disruptions in production and logistics, but also require profound structural changes in approaches to supply chain management. The modern world requires greater flexibility, resilience and adaptability in solving these complex challenges. It is also important to review and adapt economic and political strategies that take into account these changing global conditions. Growing awareness of environmental challenges and the need for sustainable development are becoming key elements in modern supply chain management.

4. Discussion

The analysis of geopolitical risks and their impact on global supply chains, carried out within the framework of the study, finds confirmation in the works of other authors. Expertise (Flouros, 2022) focuses on the impact of trade wars and international sanctions, demonstrating that the factors can lead to major disruptions in supply, increased transportation costs and reduced efficiency of supply chains. The hypothesis (Kazancoglu, 2023) is confirmed by the conclusions of the research results, where the role of transnational corporations as regulators of intercontinental routes is defined. However, the question raised in the work (Bussy, 2023) regarding the opportunities for companies to adapt and even find new opportunities in complex geopolitical conditions remains debatable. Of considerable interest is the confirmation of the thesis (Ekinci, 2022) about the role of technological innovation in reducing the impact of geopolitical risks on supply chains. According to a study (Gupta, 2022), the introduction of automation, the application of intelligent data analysis and the use of digital platforms can significantly increase the flexibility and sustainability of transport systems. According to observations (Zhang, 2023), there is a need for the integration of technological innovations for the effective management of logistics projects in conditions of political uncertainty and operational decision-making due to the reduction of bureaucratic processes. However, a study (Tiwari, 2023) highlights the potential risks associated with high reliance on technology, particularly through the threat of ineffective cyber security and data retention. According to (Iacoviell, 2022; Zayed et al., 2022), a key factor in international logistics management is the ability to predict and quickly respond to geopolitical changes. This idea reflects the approach in the article, which emphasizes the importance of developing flexible strategies and operational adaptation to new conditions of political alliances. The scientist (Gil-Alana, 2023) points to the difficulties that arise in the implementation of these strategies, especially in the context of the global scale and interdependence of modern logistics routes. According to (Phan, 2022), an important role in this process is played by international organizations and governments, which can contribute to the creation of a favorable environment for international trade and cooperation. Therefore, the discussion among scientists confirms that the impact of geopolitical risks on global supply chains is multifaceted and requires a comprehensive approach to their management. The importance of political leadership and effective cooperation is

emphasized in many studies and publications, which indicates the relevance of the topic and the need for further research into this issue.

5. Conclusion

Thus, the study examines how geopolitical risks affect global supply chains, based on the analysis of a variety of sources, including academic works, news analysis, country economic reports, technological innovations and regional characteristics. It was found that geopolitical tensions in the form of trade wars, international conflicts and political changes have a significant impact on the stability and efficiency of global supply chains. The risks lead to rising costs, supply disruptions, and the need for rapid adaptation of business strategies from multinational corporations and the restructuring of transportation systems. Technological development in the areas of automation and digitization opens up new opportunities for optimizing supply chains, although it also creates additional challenges from the point of view of cyber security and the integration of new technologies. The regional analysis showed that different parts of the world differ in the degree of influence of geopolitical risks on supply chains, depending on local economic conditions, political stability and geographical location.

In 2024, it is predicted that geopolitical risks and their impact on global supply chains may even intensify. Factors such as increased international conflicts, climate change, technological disruptions and continued political instability in some regions may lead to further uncertainty in the markets. In turn, it can cause a reduction in international trade, an increase in logistics costs and the need for greater diversification of supply sources. The introduction of new smart routing system technologies can help minimize some of these risks, but will also require significant investment and upskilling of workers. The expansion of environmental standards and regulations by world leaders will have implications for global supply chains, forcing companies to adapt to new business conditions.

Based on the results of the study, recommendations for multinational companies and governments are the need to develop more flexible and sustainable supply chain management strategies, which includes diversification of supply sources, investment in technology development, in particular automation and digitalization, and increasing the degree of transparency of transport systems. An important factor is the development of risk management strategies that can help companies quickly adapt to changing market conditions. At the level of public policies, it is important to maintain a stable and predictable trade environment, stimulate innovation, and invest in infrastructure development. Given the growing role of environmental issues, companies and governments should integrate sustainable practices into supply chain management, which will not only help reduce environmental impact, but also increase their competitiveness in global markets.

Ethical considerations

We confirm that we have obtained all consent required by the applicable law to publish any personal details or images of patients, research subjects, or other individuals used. We agree to provide "Multidisciplinary Reviews" with copies of the consent or evidence that such consent has been obtained if requested.

Conflict of Interest

The authors declare no conflicts of interest.

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