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Managing supply chains amidst geopolitical instability

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Abstract: The stable functioning of global logistics supply chains is a necessary condition for meeting consumer needs, developing production and growing the economy as a whole around the world. The current situation with global economic uncertainty is seriously testing the sustainability of international supply chains, revealing their vulnerabilities and the need for diversification. The study aims to analyse the transformation of global supply chains in the context of geopolitical changes to substantiate adequate directions and tools for managing and optimising logistics processes to achieve a competitive advantage in a dynamic business environment caused by geopolitical uncertainty using modern supply chain management platforms. The study is based on theoretical and statistical data and comparative analysis to identify the impact of global geopolitical changes on supply chain management. The publication explores the world economy's challenges due to changes in global trade relations caused by factors, including the pandemic and military conflicts. It is proved that the dynamics of international associations and the growth of protectionist policies are the driving forces that lead to the destabilisation of global supply chains and the intensification of trade contradictions. The study identifies ways to optimise global supply chains, considering integrating digital technology tools into supply chains, which can provide more accurate tracking of goods, increase transparency of operations and reduce the risks of counterfeiting and fraud.

1 Introduction

Global geopolitical processes, such as trade wars, climate change and pandemics, are radically restructuring the world economy. Global supply chains are undergoing significant changes due to geopolitical disruptions, economic instability, technological advances and cultural transformations — their complex network is becoming even more uncertain due to the constant changes in international trade. To effectively manage these chains, it is necessary to clearly understand these changes and the impact of these processes on global supply chains to reduce logistics risks and optimise them [1]. Given the current global challenges and transformations, the relevance of studying the impact of these changes on global supply chains is obvious.

High competition in the global market dictates new rules of the game. To meet the growing demands of customers, companies are forced to constantly improve their logistics processes, providing the highest level of service and ensuring impeccable quality, where the speed and quality of logistics processes are critical factors in the competitiveness of companies in a globalised world. Failure to anticipate and mitigate risks can lead to significant disruptions in supply chain operations. Inadequate analysis of potential threats can trigger unforeseen problems that negatively affect all stages of the production cycle and the ability to compete in the market. This limits opportunities for improving global supply chain management [2].

Managing global supply chains in a dynamic environment has become impossible without digital solutions. These solutions provide complete control over the supply chain, real-time tracking of goods and rapid response to market changes. Digital tools provide complete openness and transparency of business processes and control over all stages of the supply chain, enabling them to accurately track the movement of goods, control stock levels in warehouses, identify potential bottlenecks promptly and optimise logistics processes, which helps to increase business efficiency, reduce costs and improve customer service.

That is why, in today's geopolitically uncertain world, supply chain management is the art of coordinated work of all links, from producer to consumer, to deliver the right product to the right place at the right time. Solving the challenges of managing global supply chains in today's business environment requires an integrated approach considering various supply chain optimisation factors,

including supply chain performance and optimisation criteria.

2 Literature review

Academic debates and practical experience over the years have shaped the current understanding of foreign trade and geopolitics in the scientific works of many scholars. Based on the results of their study, Góes and Bekkers [3] argue that geopolitical conflicts can significantly harm the global economy; in particular, they can lead to a decrease in international trade, slower economic growth, and slower innovation processes. Rodrik [4] investigated the interaction of globalisation processes and political changes and their consequences for foreign economic relations. The researcher notes that the neoliberal model of globalisation, which preached unimpeded trade and minimal government intervention in the economy, did not always lead to the expected positive results. He argues that this model has often led to increased inequality, job losses in developed countries, and undermined social harmony. Chunikhina et al. [1] studied international trade in the context of global transformations, reviewing key trends and strategic decisions that can be used to develop effective trade policy in the context of globalisation. They argued that a systematic analysis of changes in world trade allows for more accurate forecasts and business adaptation to new conditions.

The transformation of global supply chains, especially in the wake of COVID-19, has intensified academic debate in this area. Researchers such as Sandul [5], Tereshchenko and Yevtushenko [2], Song et al. [6], Tullio [7] find that protectionism, mainly through non-tariff barriers, affects how fast global trade grows compared to the growth of the world economy. Khorana et al. [8] analysed how global supply chains respond to sharp supply and demand changes in the face of increased protectionism, including the benefits and risks this brings to companies affected by the COVID-19 pandemic. Protectionist measures, such as duties and quotas, can protect new or weak sectors of the national economy from foreign competition, giving them time to develop; import restrictions can help preserve jobs and reduce dependence on imports of strategically important goods. However, in their opinion, protectionism can slow down economic growth in the long run as it limits access to cheaper and more efficient resources and technologies.

Analysing the experience of the international business community in overcoming crises, Buckley [9] notes that the disruption of global trade networks requires them to rethink strategies and seek new opportunities. According to the researcher, modern corporate strategies should be more comprehensive and consider social and political contexts, especially in rising nationalist sentiment. Non-market factors, such as geopolitical tensions, are forcing multinationals to focus on increasing their flexibility, expanding their network of partnerships, and adapting business models to changing conditions in global markets. Manag Rev [10] and Mishra et al. [11] emphasise the importance of proactive planning, collaboration, and adaptability of chosen paths in uncertain and complex environments to mitigate the adverse effects of disruptions and ensure the continuity of global supply chains. According to Noble [12], combining lean and agile will increase customer satisfaction and competitiveness and reduce costs, creating a more sustainable and efficient supply chain.

The issue of supply chain optimisation in times of crisis is discussed in detail in Kryveshchenko et al. [13], Zavadska et al. [14], Mittal [15]. Nandy and Md. Mamun Habib [16] emphasise the need for proactive management and rapid response to change. Researchers are deepening their understanding of logistics decision-making processes, particularly regarding uncertainty and risks accompanying global supply chains. The challenge of effective supply chain management in times of crisis is discussed in detail by Remzina [17], who emphasises that success depends on the ability to adapt quickly to change. Bradley and Alderman [18] note that in difficult situations, ready-made solutions are needed that can be used to quickly adapt to changes, as well as to implement innovative solutions to optimise management processes.

The international company McKinsey and Company has conducted several studies in the field of logistics: Alicke and Strigel [19] substantiated the issues of risk management in logistics supply chains; Bartman et al. [20] substantiated the current changes and global challenges in the logistics sector; and Dautner [21] optimised global logistics supply chains. The researchers describe the new types of risks that have emerged in global supply chains in recent years, such as cyber threats, climate change, and pandemics, and offer various strategies and tools for managing them in supply chains. Diversifying suppliers, building inventories, and using innovative technologies to track risks allow us to respond to existing problems, anticipate potential threats and develop measures to prevent them.

In the context of the development of Industry 4.0, researchers led by García-Reyes [22] identify how to modernise supply chains. They propose areas that allow for the gradual integration of new technologies while increasing the flexibility, resilience, and reliability of logistics processes [23], such as increasing efficiency, saving money, and improving customer satisfaction, redesigning supply chain processes to take advantage of digital opportunities, creating reliable processes for collecting, storing, and analysing data. Hassani et al. [24] emphasise that seemingly contrasting models (Lean emphasises efficiency, Agile emphasises flexibility) can be combined to manage a global supply chain effectively. However, only if the need for efficiency is balanced with the need for flexibility. For example, a company can use Lean principles to reduce waste in production while using agile methods to respond quickly to changes in customer demand.

The maturity of supply chain management in terms of sustainability is relevant today in the context of following sustainable development, as noted by Reefke and Sundaram [25], Hong et al. [26]. Digital solutions such as process automation, accurate accounting, warehousing optimisation, and data analytics give companies complete control over their inventory and shipments and identify potential problems at an early stage, as highlighted by Shpak et al. [27]. Although big data technologies are still in their infancy, they are already playing an essential role in transforming various industries, including by facilitating the development of new services, increasing the competitiveness of companies, and developing innovative logistics solutions [28]. As Colback [29] notes, the introduction of digital solutions such as warehouse management systems (WMS), enterprise resource planning (ERP) and transportation management systems (TMS), and the use of blockchain technology to securely and transparently track goods throughout the supply chain, improve agility and response to force majeure disruptions, and reduce costs and waste in the supply chain.

The existence of a significant scientific body of work does not alleviate the urgency of the issue, as the scale of global geopolitical uncertainty in global supply chains requires new solutions that can only be found through further research. The changing global context requires updated management approaches in global supply chains.

The research aims to analyse the transformation of global supply chains in the context of geopolitical changes to substantiate adequate directions and tools for managing and optimising logistics processes to achieve a competitive advantage in a dynamic business environment caused by geopolitical uncertainty using modern supply chain management platforms. Considering the global digitalisation trend, the study aims to identify bottlenecks in the existing global supply chain management system and develop measures to address them in unstable global trade.

3 Methodology

The research methodology involved the collection of theoretical and statistical data, their comprehensive analysis and comparative evaluation in order to identify patterns and trends in the impact of global geopolitical changes on international associations and trade policy in order to increase the sustainability of global supply chains and the volume of investment in the technological development of logistics at the global level. The observation method allowed us to identify long-term trends and patterns necessary for understanding the processes in the geopolitical environment, which primarily affects global supply chains. The abstraction method was used to identify general patterns characteristic of the transformation of global supply chains in times of geopolitical uncertainty and to draw conclusions that can be used to predict this area's future development.

The study of the transformation of global supply chains was based on the application of such a method as analytical diagnostics, which allowed us to identify the main trends of global changes in the geopolitical environment, the dynamics of changes in the international trade community and the problems associated with this sweet economic and political phenomenon. The statistical analysis of the total value of logistics operations by target regions provided a multifaceted picture of how global political changes affect global supply chains and international trade volumes. It is worth noting that there is a significant gap in the development of decision-making methodologies in global supply chain management, especially in the face of uncertainty and multiple criteria.

4 Results and discussion

The global economy is going through a period of turbulence associated with increased protectionism and trade barriers, which is provoked by the growth of nationalist sentiment. The rapid development of technology, especially in transport and communications, has become a powerful catalyst for global economic integration. The transition to Industry 4.0 requires companies to rethink their approaches to supply chain management, considering the growing interdependence of economies and the rapid development of technology. Companies have been actively expanding their supply chains beyond national borders for cost savings. Economic motives drove this process, although it was accompanied by disregarding certain risks associated with globalisation [5].

After a tumultuous period of pandemic and subsequent stagnation, logistics is transforming profoundly through a wave of mergers and acquisitions. These processes are not only changing the landscape of the industry but also shaping new areas for investment and development. Increased geopolitical instability and stronger protectionist policies during this period significantly impacted the decline in international trade. Figure 1 shows that, after the accelerated development caused by the pandemic, global supply chains went into slow motion in 2023, but analysts predict a new round of activity in 2024 [20].

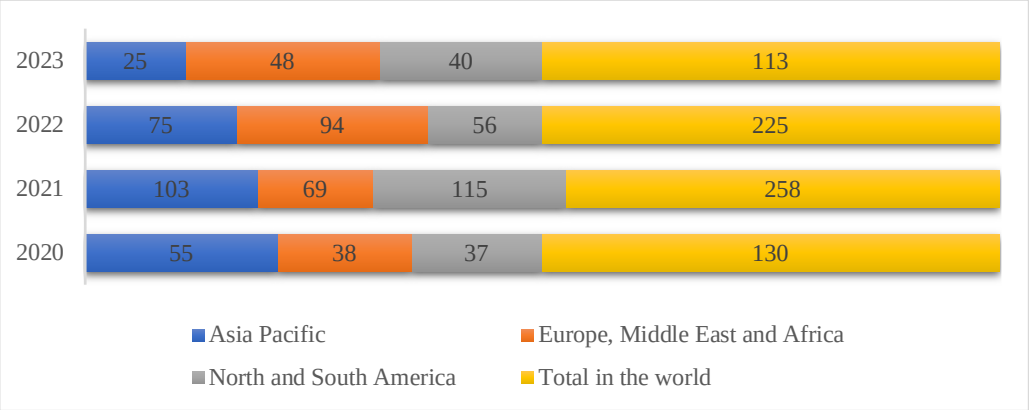

Figure 1 Total Value of Logistics Operations by Target Region, billion USD
Source: compiled by the author based on data from [20]

Growing geopolitical tensions are leading to the fragmentation of global supply chains and their increased dependence on non-market factors. Changes in trade policy are a direct stimulus for the growth or decline in trade volumes. Protectionist policies, which impose trade barriers such as duties and quotas, hurt international trade volumes. In contrast, free trade agreements, which eliminate tariff and non-tariff restrictions, stimulate trade growth between countries, and the formation of international trade associations support the resilience of global supply chains (Figure 2).

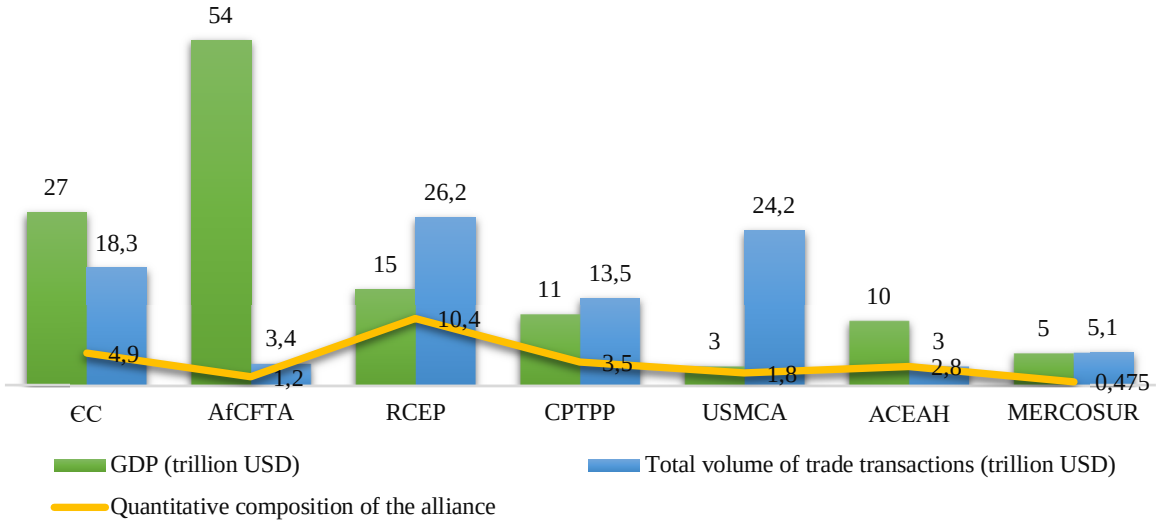

Figure 2 Major International Trade Associations for 2022–2023
Source: built by the author based on [30]

This trend is driven by the fact that international unions and associations do not stand still but actively respond to changes in the global economy. In 2022–2023. The EU focused on the digital transformation of the Single Market and enhancing economic resilience. The African Continental Free Trade Area is actively developing and focusing on digitalisation. The RCEP has become a powerful engine of economic growth in the Asia-Pacific region. providing favourable conditions for trade and investment. The Trans-Pacific Partnership Agreement has successfully continued to realise its trade liberalisation and regulatory harmonisation goals. The USMCA contributes to improving trade security in North America. ASEAN continues to work actively to strengthen economic ties between the region's countries. contributing to their joint development. The South American trade bloc was established to liberalise trade and factors of production between the region's countries and strengthen economic integration. Despite this. The bloc's foreign trade relations remain heterogeneous. as evidenced. in particular. by the complex process of negotiating an agreement with the European Union [1].

Geopolitical conflicts and new international trade rules have become the main drivers of changes in world trade.

which have been initiated by broader global political processes. as noted by Góes and Bekkers [3]:

- The expansion of military blocs such as NATO creates a paradox: on the one hand. it increases security and promotes economic growth. but on the other hand. it can provoke conflicts and limit trade relations;
- Due to the rivalry between China and the United States and difficulties in NATO. countries are reviewing their trade relations and trying not to depend on one country or region;
- In the context of rising international tensions. economic sanctions are becoming an instrument of geopolitical pressure that can lead to trade wars and redistribution of global economic resources;
- Changes in international security and political alliances are forcing companies to rethink their supply chain management strategies. as the regional integration that results from these changes creates both new risks and opportunities for businesses;
- The armed conflict in Ukraine hurts the volume and structure of international trade. mainly through rising prices.

The reorganisation of trade and economic associations and the adaptation of trade strategies open up new opportunities for the development of international trade. but they also carry certain risks. Given this. it is crucial to highlight the main ones associated with changes in geopolitical alliances and trade policy that could disrupt the smooth operation of global logistics networks (Figure 3).

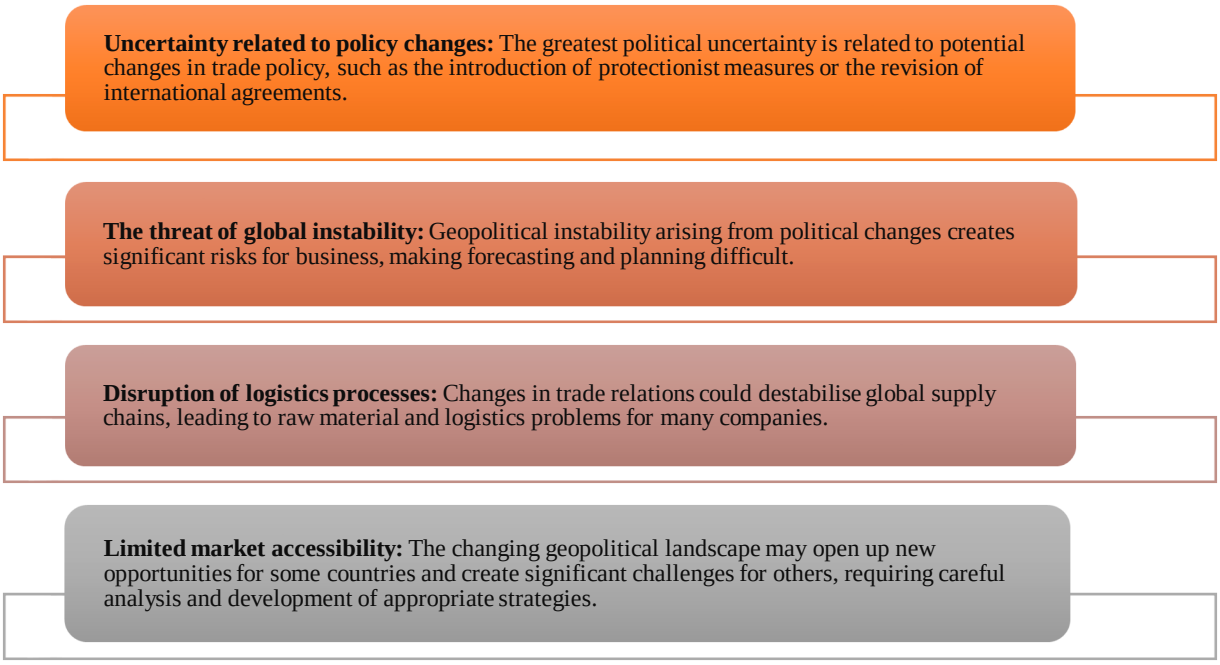

Figure 3 Risks of Global Supply Chain Destabilisation as a Result of Geopolitical Challenges
Source: compiled by the author according to [1]

The rapid pace of globalisation and technological development is forcing businesses to make new choices. requiring them to constantly adapt to changing conditions and build resilient supply chains that can withstand any threat. Based on the pandemic's experience. governments and businesses are developing new models of global supply chains that will be more flexible and adaptive to unforeseen events. Increasing the resilience of supply chains remains a critical task even for the world's largest companies. This process encompasses various activities. from analysing potential threats to using modern technologies and collaborating with partners to create reliable supply chains [19].

As noted by McKinsey and Company (Figure 4). The trend towards investing in technology to reduce costs and increase productivity is becoming increasingly noticeable.

With supply chain finance. exporters and importers can flexibly adjust payment terms. maintain liquidity and ensure the smooth flow of goods and funds between countries. Sustainable finance combines social responsibility with economic benefit. meeting customers' needs and seeking sustainable development. Sustainable finance is expected to be a crucial factor in building sustainable supply chains. and supply chain sustainability will become a new criterion for investment decisions [16].

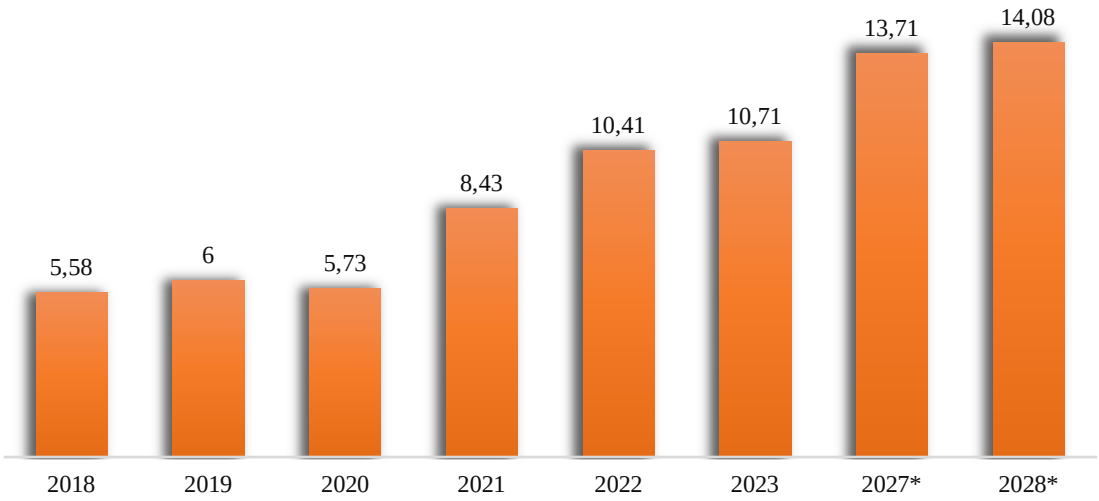

Figure 4 Investments in Logistics Technology Development at the Global Level. trillion USD
Source: [31]

Logistics is a critical factor in ensuring the continuity of business processes in the face of uncertainty. It is essential to clearly understand what criteria determine the efficiency and sustainability of logistics processes. The critical point of optimisation is to establish the optimal criteria for assessing the effectiveness of the supply chain management strategy under conditions of uncertainty. The main criteria are the system's ability to self-adjust. flexibility in responding to changes. resource efficiency. and resilience to external threats [15]. A key element of successful supply chain optimisation is implementing a system of key performance indicators (KPIs) that accurately assesses how effectively the chosen strategy is being implemented. High efficiency is achieved by improving production efficiency by increasing throughput. eliminating bottlenecks and shortening the production cycle. increasing labour productivity. optimising logistics processes and accelerating the turnover of material resources. To minimise the risks associated with uncertainty. strategies to increase the resilience of global supply chains should be applied. as shown in Table 1.

Table 1 Strategies for Optimising Global Supply Chains

Strategy	The essence of the strategy	Areas of application	Advantages of use
Multisourcing	Create backup supply channels	Distributing risks among several sources to minimise the impact of crises	Ensures high security of supply. competitive prices. continuous improvement of product quality and access to the latest technological developments
Niaschoring	Bringing production closer to the consumer	Complete control over all stages of the supply	Speeds up order fulfilment and reduces transport costs
Decentralisation of production	Territorial distribution of production	Reduce logistics costs and increase delivery speed	Reduces the risk of supply chain disruption
Interoperability	Implementation of a single quality standard	Systematisation of actions at all levels of the supply chain	Increases the productivity and efficiency of all business processes
Maintaining surplus production assets	Creating stock or production capacity reserves	Increase in inventory or production capacity	Insure against possible supply disruptions and increase the resilience of supply chains
Building strategic alliances	Creating mutually beneficial partnerships	Entering the shared logistics ecosystem	Encouraging joint efforts. market interaction and exchange of experience.
Flexibility of supply	Creating adaptive logistics networks	Investing in dynamic logistics systems	Ensures prompt adaptation to changing market conditions
Digital modernisation	Introduction of digital tools	Blockchain. AI and cloud computing in supply chain management	Enables supply chain transparency. intelligence and scalability

Source: added by the author based on [13]

Significant fuel price increases. labour shortages and the destruction of transport infrastructures have created a critical situation that requires a radical restructuring of logistics processes using the most advanced technologies.

Digital transformation has become a necessity for global supply chains. which are facing unprecedented challenges. Thanks to IT tools. the supply chain's transparency. efficiency. and responsiveness are reaching a new level. Digital solutions enable tracking every stage of the goods' movement from producer to consumer. monitoring stock levels in warehouses. and detecting possible delays or problems in time [18]. A wide range of software solutions help increase the productivity of the entire supply chain (Figure 5).

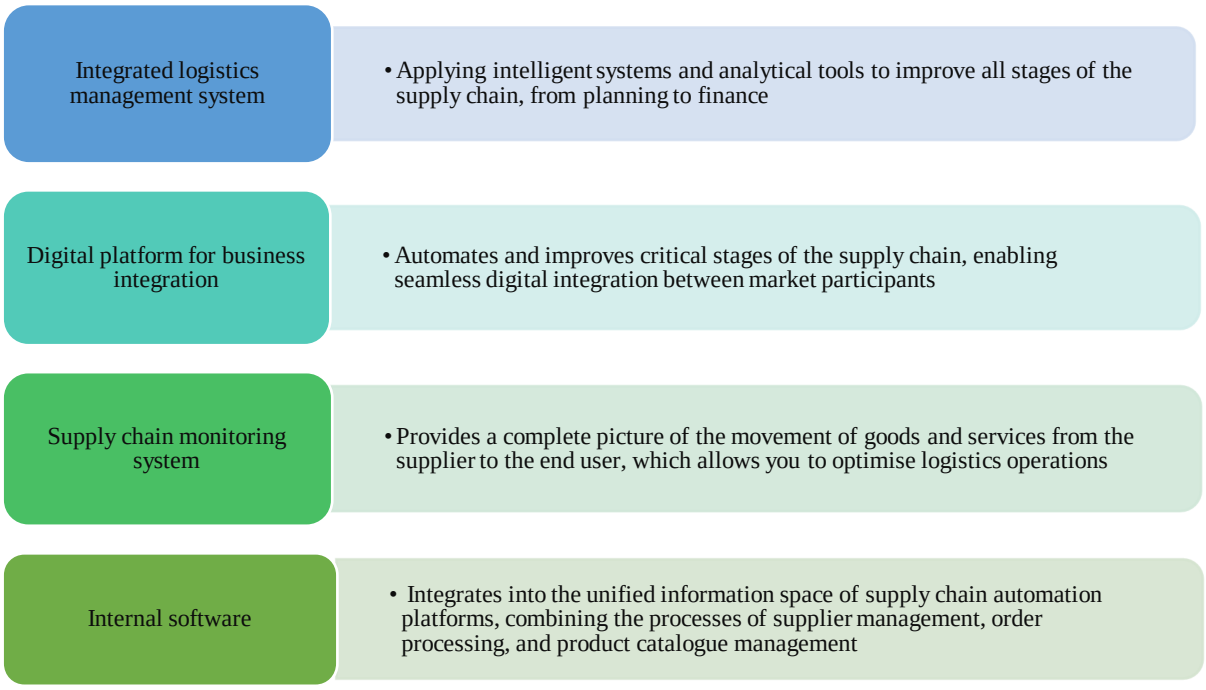

Figure 5 Supply Chain Management Platforms
Source: based on [14]

To achieve maximum transparency and control over task execution. systems that store reliable and undistorted data must be developed. Blockchain technology. for example. guarantees the highest level of data security. making it impossible to tamper with or access unauthorised data. IoT sensors have transformed supply chains into interactive systems where each product has its digital passport containing detailed information about transportation conditions. allowing companies to ensure product quality and meet customer requirements [24].

Digital platforms improve communication and facilitate financial transactions between supply chain partners. ensuring transparency and efficiency of payments [29]. Digitalisation transforms static supply chains into dynamic networks that provide greater transparency. efficiency and adaptability. Integrating heterogeneous big data provides a comprehensive supply chain analysis. enabling quick and informed decisions to be made in a dynamically changing environment [28].

The active formation of global supply chains. driven by globalisation. has been significantly hampered in the 21st century by the growing number of global crises. The COVID-19 pandemic has become a vivid example of such events. which have led to an unprecedented slowdown or even halt in production processes in various industries. thereby negatively affecting the structure and models of supply chains [6]. In addition. optimising global supply chains in times of crisis is a complex process that requires an integrated approach. It is necessary to introduce modern technologies. diversify suppliers. optimise inventory and inventory management. ensure transparency and traceability. invest in own logistics. improve cooperation between chain participants. and adapt quickly to changes.

The global processes of recent years have triggered large-scale changes in international trade. creating new opportunities and challenges for businesses and economies worldwide. It is necessary to critically analyse the transformational processes in global trade to understand their impact on the development of global supply chains. Analysing global supply chains as an integral part of economic ecosystems allows us to understand their impact on economic growth and social development. Analysing the critical factors shaping modern supply chains will allow companies to develop effective strategies for optimising global supply chains to adapt to new market conditions and create a future-oriented business [5].

Geopolitical conflicts. including trade wars between major economies. have exposed deep divergences in the

perception of democratic and liberal values between Eastern partners and the Global West. leading to increased instability in global supply chains. Globalisation opens up new horizons for market expansion and cost optimisation in supply chains. but companies must also consider the risks associated with growing de-globalisation trends. Successful global operations management requires constant balancing between changing geopolitical conditions. complex regulatory requirements. volatile trade relations and adapting quickly to changes. Geopolitical risks have pushed companies to rethink their globalisation strategies and look for more local and regional solutions [29].

The increasing complexity of global supply chains and stricter sustainability requirements force companies to reconsider their management approaches. Particular attention is paid to the responsible selection of partners. minimising the negative impact on the environment and ensuring compliance with ethical standards at all stages of production [10]. The urgency of this transition is related to the need to adequately respond to systemic shortcomings that manifest themselves in the form of negative externalities resulting from a long-term underestimation of the risks associated with market dysfunctions and government regulation [32].

Today. the European Union is a leader in promoting sustainable development. focusing on the financial sector by redirecting investment to environmentally friendly projects and limiting funding for environmentally damaging businesses. The new sustainable finance regulations will make the integration of ESG criteria into supply chains mandatory for all companies. Companies must comprehensively assess their environmental and societal impacts. including greenhouse gas emissions. resource consumption. labour conditions. and supplier performance [33]. Failure to comply with the requirements may restrict suppliers' access to finance and loss of business development prospects. In particular. implementing sustainability standards can devastate the development of countries on the path of modernisation.

As geopolitical competition intensifies and countries seek to protect their markets. large companies must reconsider their business model. They are likely to rely less on global production chains and build more local production facilities to meet the needs of consumers in their regions [14]. This is due to the desire to reduce the risks associated with supply disruptions and increase their resilience to external challenges. However. the decline in globalisation will not necessarily lead to the destruction or radical change of production chains – many companies are beginning to actively work to strengthen their supply chains.

Global supply chains must be flexible and adaptive to survive in a constantly changing environment. The critical characteristic of an adaptive global supply chain strategy is its ability to change quickly in response to unforeseen circumstances. such as market changes or customer needs. Unlike traditional supply chains. agile supply chains are characterised by close collaboration between all participants. rapid data exchange. and innovative technologies. allowing them to respond quickly to market changes [16].

Effective supply chain management in the face of global crises requires not only the use of modern technologies but also a deep understanding of the relationships between all elements of the chain and the ability to quickly adapt to changes in the external environment [34]. The introduction of digital platforms allows for the automation of many processes in the supply chain. reducing the number of manual operations and minimising the risk of errors. The transition from linear to networked supply chains is a key trend in modern logistics. which is enabled by digital technologies.

In a dynamic market environment. where supply chains are constantly subject to change and risk. it is critical to regularly evaluate information on orders. prices. deliveries and other factors affecting logistics operations' efficiency. The key to effective supply chain management in a volatile environment is clearly defining and regularly monitoring key performance indicators that consider all these criteria. In order to adapt to changing conditions and maintain the stability of logistics operations. it is necessary to systematically monitor and analyse key performance indicators that consider these criteria [2].

5 Conclusions

Global instability caused by wars. economic crises. and technological revolutions transforms every aspect of international relations. including global supply chains. Global supply chains play a crucial role in today's world. influencing economies. politics. and people's lives. Understanding their role and the challenges they face is essential for effective decision-making at the national and international levels.

1. The study shows that global change is a powerful driver of transformation in international trade. The emphasis on achieving sustainable development goals in logistics has shifted from declarations to concrete actions. which is especially relevant for global supply chains. where companies must ensure transparency of operations and implement a range of environmental measures.
2. Geopolitical. economic. technological. and cultural factors significantly impact international trade relations and the formation of alliances between states. Exports and imports. trade balance. tariff rates. and global integration indices are key indicators. and analysing the dynamics allows us to assess the impact of these factors on international trade. The growth of globalisation makes it necessary to have an efficient and well-managed supply chain. as it is becoming an essential element for international business.
3. It is determined that managing global supply chains under uncertain conditions involves a detailed study of the company's financial condition. risk assessment.

development of plans to restore solvency. and implementation of measures to stabilise operations. The shaky balance of international alliances and the growth of protectionism have led to high uncertainty in global markets.

4. The introduction of the Internet of Things and artificial intelligence in logistics significantly increases productivity. process efficiency and customer service. In the context of globalisation and a changing market. digital solutions are becoming indispensable for navigating the complexities of global supply chains and maintaining a competitive edge.

The complexity of modern business requires professional management of global logistics supply chains to achieve maximum efficiency. Volatility and uncertainty emphasise the need to focus on adaptability. flexibility and efficiency when optimising logistics management processes. KPIs help identify global supply chain bottlenecks and develop measures to address them. The systematic evaluation of all relevant data is critical to the effective planning and execution of logistics operations in a global environment.

It is worth noting that optimising global supply chains in the face of global crises is not just a sum of individual measures but a set of interrelated actions. Modern technologies. supplier diversification. inventory optimisation. transparency. investment in own infrastructure. cooperation between chain participants. and adaptation to changes are all integral components of successful optimisation. The proposed solutions can contribute to creating new business models in global logistics that will allow for successful operations in a highly competitive and uncertain environment.

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