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Modeling supply chain disruptions due to geopolitical Reasons: A systematic literature review

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ABSTRACT

This article aims to improve understanding of how to manage supply chain threats from geopolitical disruptions. To achieve this, the work conducted a systematic literature review and content analysis of 80 articles, examining both the impacts of geopolitical disruptions and the supply chain management decisions made in response. The analysis identifies six distinct types of geopolitical supply chain disruptions, along with their respective effects and corresponding managerial decisions. Their connections are illustrated through specific models tailored to each geopolitical disruption. Accordingly, the article also provides a framework summarizing strategies for mitigating, responding to, and recovering from each geopolitical disruption. This reveals that financial management, collaboration, resilience and, viable supply chain management are effective strategies for dealing with all geopolitical disruptions. However, digitalization, financial innovation management, location management, security management, risk management, circular economy, and sustainable supply chain management have a limited effect on some geopolitical disruptions. The article concludes by suggesting 16 directions for future research and offering practical insights for managers and policymakers.

1. Introduction

Products demanded by consumers are produced and distributed using supply chains made up of raw material suppliers, factories and production facilities, as well as distribution facilities that supply retail locations with goods for consumers to purchase. In the past several decades, supply chains have become more geographically dispersed due to the opening of new markets, faster flows of information, and cheaper, more reliable and efficient transportation costs (Chopra and Sodhi, 2014; Christopher, 2016). Recently, supply chains have become more vulnerable and increasingly affected by a growing number of disruptions that significantly impact their operations. This vulnerability stems from various causes, such as excessive leanness and efficiency (Pettit et al., 2010), increased volatility of demand (van Hoek and Dobrzykowski, 2021), reduction of key suppliers (Pettit et al., 2010), centralization of distribution (Pettit et al., 2010), or the international location of key agents in global supply chains (Blackhurst et al., 2017; Kleindofer and Saad, 2010), among others. For example, offshoring initiatives and production internationalization decisions were conducted by many firms (Levy, 2005), but after some years, some challenges arose, such as quality issues, lack of flexibility (López and Ishizaka, 2019), long

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delivery times (Ellram et al., 2013), and increased costs (Fratocchi et al., 2014; Grossman et al., 2023), among others, which made firms reconsider their location decisions towards backshoring or reshoring back home.

Chopra and Sodhi (2004) identified different types of risks as well as some mitigation strategies to manage them to avoid supply-chain breakdowns. One of these risks is disruptions in supply chains, something that has become spectacularly evident over the past five years. Causes for global supply chain disruptions include, e.g., natural disasters, financial crises, and terrorist attacks. In 2020, the coronavirus unleashed a global pandemic, killing millions of people and disrupting supply chains around the world in ways we even now continue to grapple with (Ali et al., 2022; Ivanov, 2020; López et al., 2022). A report stated that 94 % of Fortune 1000-listed companies were affected by supply chain disruptions during the early stages of the pandemic (Sherman, 2020). Worker shortages due to health and safety issues led to unplanned and unexpected capacity shortfalls, which in turn affected other parts of the supply chain when material, e.g., from suppliers, could not be received in time. Transportation nodes were also affected by personnel shortages, which led to both an increase in the lead time as well as increases in the variability of the lead times. These supply chain effects were overcome by digitizing and developing adaptability strategies with intertwined supply chains that ensured their survival (Brookbanks and Parry, 2024; Ivanov, 2021; Ivanov and Dolgui, 2020).

In the post-pandemic era, the blockage of the Suez Canal by the Ever Given caused delays in the delivery of millions of containers that transited through this maritime highway (Shih, 2022). So, while today's global supply chains are great at fulfilling demand efficiently, they are also prone to disruption and ripple effects that profoundly and persistently plague supply chains for months and, in some cases, years. However, not all disruptions are the same, and a global pandemic is different from an accident involving a container ship at a logistics bottleneck, which is different from a disruption due to geopolitical reasons.

In February 2022, Russia invaded Ukraine, an escalation of the Russo-Ukrainian War that started in 2014. The effects of this unwelcome invasion were not only the shattered belief that the world had entered a time after World War II that unlawful military landgrabs no longer happened. From changed flows of commodities and food (Stackpole, 2022) to scantiness of spare parts and components (Noble, 2022), coupled with sanctions and China-US trade disputes, has left supply chains even more disturbed (Simchi-Levi and Haren, 2022).

Recently, in October 2023, a Hamas surprise attack on Israel led to a new chapter in the age-old conflict, as Israel declared war and reoccupied large parts of Gaza. The immediate effect could be seen as fewer containers were shipped to Israel from European ports in the weeks after the outbreak of war (Murray, 2023), though the ports remained functioning despite rocket attacks on port facilities (Saul, 2023). Concern about the availability of computer chips, semiconductors, and electronic components did not escape the immediate attention of the popular business press (King, 2023). Most recently, the vehicle carrier ship Galaxy Leader was highjacked in the Red Sea by Houthi rebels and towed to a port in Yemen, making many worry that ships are now increasingly prone to hijacking as well as missile and drone attacks as they head to and from the Suez Canal on this essential maritime trade route (Gambrell, 2023).

For all the above-mentioned, the disruptions within the supply chain have been a recurrent research topic that has drawn attention to the academia for many years. More than 50 literature reviews have been published since 2020 about disruptions in supply chain related to concepts such as resilience [i.e., (Gupta et al., 2024; Kassa et al., 2023)], risk management [i.e.,(Gurtu and Johny, 2021; Shekarian and Mellat Parast, 2021)], technology (as blockchain, data analytics, digital innovation, or industry 4.0, among others) [i.e., (Benabdellah et al., 2024; Unhelkar et al., 2022)], Covid-19 and consequences [i.e., (Kapoor et al., 2024; Kumar et al., 2024; Pujawan and Bah, 2022)], or specific industries (as food, healthcare, or humanitarian sectors, among others) [i.e., (Nguyen et al., 2023; Perdana et al., 2022)]. Even though recent literature indicates that over the recent years, many critical disruptions in global supply chains have been due to geopolitical tensions (Ali et al., 2024; Kaya, 2024; OECD, 2024), there is a need for investigation into this topic, as indicated by (Bednarski et al., 2023; He et al., 2022). To the best of our knowledge, only one literature review article has been published about disruptions in supply chains due to geopolitical reasons (Bednarski et al., 2023). This work studied how geopolitical disruptions affect the configuration, flow, and management of global supply chains. However, it did not establish the types of geopolitical disruption and analyze their concrete effects and decisions adopted to overcome or mitigate them particularly. Therefore, this gap remains unaddressed in the literature.

Hence, the main aim of this article is to provide a comprehensive analysis of the main disruptions of supply chains due to geopolitical reasons, the effects of the disruption, and any management mechanisms that have been implemented or could potentially be implemented to decrease the severity of the impact. The secondary aim is to model them in order to identify any gaps and suggest future research aims.

Accordingly, we will conduct a systematic literature review (SLR) and content analysis to answer the following research questions (RQs):

RQ1. What are the main disruptions studied by supply chain management academic literature due to geopolitical reasons?

RQ2. What are the effects produced by the above-mentioned disruptions?

RQ3. What managerial supply chain strategies and decisions have been adopted to respond, mitigate, and/or recover after these effects?

RQ4. What are the main future research directions according to the analyzed literature?

The remainder of this paper is organized as follows. In the following section 2, we provide the research background. Section 3 describes the methodology used to design and conduct the SLR for the content analysis. Section 4 will present the descriptive results of the SLR. Section 5 describes the geopolitical supply chain disruptions identified in the research. Additionally, this section provides and discusses the specific models developed by each geopolitical supply chain disruption identified in the research. Section 6 discusses the theoretical, managerial, and political contribution of the research. Additionally, it proposes potential future research in the context of geopolitical disruptions. Finally, section 7 summarizes the conclusions and research limitations.

2. Research background

2.1. Managing supply chain disruptions

The disruptions of supply chains have attracted the attention of both academics and practitioners for some time, stemming from the field of supply chain risk. Chopra and Sodhi (2004) listed disruptions as one of the categories of supply chain risk, noting that disruptions are typically unpredictable and rare but damaging and would include natural disasters, labor strikes, fires, and terrorism. They further suggested the classic mitigation strategies of supplier redundancy and inventory buffers.

One decade later, Chopra and Sodhi (2014) focused on exploring the impacts of natural catastrophes on supply chains. They noted that these disruptions have a domino effect, propagating risk through ripple effects as the disruption spreads in the supply chain. They also argued for segmenting and regionalizing the supply chain in addition to increasing the likelihood of supply chain disruption in supply chain planning.

Around the same time, Simchi-Levi, Schmidt, and Wei (2014) included, interestingly, Hurricane Katrina and the SARS outbreaks as motivating examples of supply chain disruption triggers, precursors to the correlated climate change weather events and the virus pandemic that we have experienced in the past years. They advocated examining the time to recover (TTR), leading to a risk exposure index (REI) score for suppliers, classifying risks as high and low, and ensuring the identification of hidden risks.

After this, it appears that substantial attention was drawn to supply chain disruption, as evidenced by several literature reviews published over a relatively short period of time in more scholarly peer-reviewed journals. Each of these reviews takes a slightly nuanced focus. Ivanov et al. (2017) focused on the recovery from disruption, using inventory, capacity, or dual suppliers in order to mitigate risks in production, procurement, and transportation. Bugert and Lasch (2018) focused on reviewing models on supply chain disruption risks using systems dynamics and discrete event simulation. They classify disruptive triggers into two main categories of natural versus man-made. Bier, Lange, and Glock (2020) focused on managing and mitigating risks in complex supply networks, classifying risks into high versus low impact and high versus low probability. Duong and Chong (2020) emphasized supply chain collaboration and coordination as a way to mitigate disruption risk. They suggested coordination mechanisms of increasing sophistication as the severity of disruption increases. Xu et al. (2020) looked at disruption and resilience in supply chains through a bibliometric analysis of citations. Sabahi and Parast (2020) reviewed how firm innovation can enhance specific resilience capabilities in supply chains. Moretto and Caniato (2021) focus on the role of supply chain finances in mitigating financial disruptions. Katsaliaki, Galetsi, and Kumar (2022) emphasized the use of IT tools to enhance supply chain resilience in the face of disruptions and ripple effects. They note that disruptions can be classified as to which activity they disrupted (production, supply, or transportation), the reason behind the disruption (man-made versus. nature), the frequency of occurrence, the nature of the disruption (demand, supply, process, control, environment), and whether it was internal or external to the supply chain. On the other hand, disruptive events are classified by type, intensity, duration, source, and impact. It is precisely the rapid spread of internet-based technologies that are leading to cyberattacks affecting logistics and supply chain operations. Hence, Cheung, Bell, and Bhattacharjya (2021) reviewed literature identifying measures to combat the disruption threats of cyberattacks in supply chains.

Most recently, Rungtusanatham and Johnston (2022) advocated six practices to manage supply chain risk through the ADDAPT approach, which stands for Anticipate, Detect, Diagnose, Activate resources, Protect, and Track. This research stated that supply chain disruptions are becoming more frequent, and consequently, firms should be prepared to move from one disruption to another.

Holgado and Niess (2023) went a step further, providing a conceptual framework based on responses, recovery, and strategic decisions for managing global supply chain resilience. Circular economy and sustainable management have also been shown to reinforce supply chain resilience when facing disruptions (Dwivedi et al., 2023; Eggert and Hartmann, 2023; Piila and Sarja, 2024). This is also achieved through the advanced 4.0 digital transformation of supply chains (Belhadi et al., 2024b; Brookbanks and Parry, 2024). On the contrary, offshoring and outsourcing strategies made the supply chain more vulnerable to significant disruptions. Hence, locations and adaptability strategies have been adopted to guarantee supply chain resilience (Choudhary et al., 2023; López and Ishizaka, 2019) and viability (Chervenkova and Ivanov, 2023; Ivanov, 2021).

Therefore, the management of supply chain disruptions is linked to supply chain collaboration, supply chain digitalization, financial management, innovation management, location management, security management, risk supply chain management, resilience supply chain management, viable supply chain management, circular economy, and sustainable supply chain management.

2.2. Key theories used in prior literature on the management of supply chain disruptions

Supply chain disruptions have been viewed through several dominant theories, such as: Resource Dependence Theory (RDT), Dynamic Capabilities Theory (DCT), Institutional Theory (IT), Transactional Cost Economics (TCE). And Complex Adaptive Systems Theory (CAST).

RDT posits that organizations are not self-sufficient; they rely on external resources for survival and success (Pfeffer and Salancik, 1978). This dependency creates power dynamics, as organizations must navigate relationships with external entities that control these essential resources. To mitigate uncertainty and manage dependencies, organizations may adopt strategies such as forming alliances, mergers, or altering their structures (Davis and Cobb, 2010; Hillman et al., 2009; Pfeffer and Salancik, 1978). Drawing upon the lens of the RDT, Zhu et al. (2024) integrate geopolitical risk into the supply chain risk management framework, demonstrating that diversification of the supply chain base is associated with a firm's improved financial performance when high geopolitical risk.

DCT focuses on an organization's ability to adapt, integrate, and reconfigure internal and external competencies to address rapidly changing environments (Teece et al., 1997). It emphasizes the importance of strategic management in building and sustaining

competitive advantage through continuous innovation and responsiveness (Eisenhardt and Martin, 2000; Teece, 2018, 2007; Teece et al., 1997). Belhadi et al. (2024a) formulate a framework based on DCT for supply chains in vulnerable areas to leverage digital technologies to design resilience strategies to manage uncertainty due to disruptions caused by geopolitical reasons.

IT examines how institutional environments influence organizational structures and behaviors (Meyer and Rowan, 1977). It suggests that organizations conform to established norms, values, and rules within their institutional context to gain legitimacy and ensure survival (DiMaggio and Powell, 1983; Meyer and Rowan, 1977). Building on an IT perspective, Roscoe et al., 2022) identify a constrained management decision-making logic when redesigning global supply chains, particularly when facing uncertainty due to geopolitical disruptions.

TCE is a theoretical framework that examines the cost of transactions as a fundamental factor in determining the organization and boundaries of firms (Coase, 1937; Williamson, 1975). TCE suggests that firms exist to minimize the costs associated with market transactions, such as searching for information, negotiating contracts, and enforcing agreements. When these transaction costs are high, firms may choose to internalize activities to reduce uncertainties and inefficiencies. Conversely, when transaction costs are low, firms are more likely to outsource or engage in market exchanges. TCE emphasizes factors like asset specificity, uncertainty, and frequency of transactions in determining the most efficient governance structure—be it market, hierarchy, or hybrid forms (Williamson, 1985). Drawing upon a combined perspective of resource dependence theory and TCE. Fan et al. (2024) analyze the impact of geopolitical conflicts as trade wars on cross-border buyer–supplier transactions and global suppliers' capabilities to mitigate disruption risks.

Finally, CAST views organizations as complex, dynamic systems composed of interconnected agents that adapt and evolve in response to environmental changes (Stacey, 1996). It emphasizes nonlinearity, emergence, and self-organization within organizational contexts (Anderson, 1999; Brown and Eisenhardt, 1997; Levinthal, 1997). Ibrahim et al. (2021) examine COVID-19 pandemic and other recent global disruptions in global value chains from the perspective of CAST, recommending the application of some of its tools like "adaptive management," and empowering "policymakers to better attract GVCs to their borders by prioritizing the creation of more resilient underlying systems".

2.3. Geopolitical supply chain disruptions

Where supply chain disruption has enjoyed considerable attention in the scientific literature, work specific to supply chain disruptions due to geopolitics is considerably sparser. That said, contributions on geopolitical risk from the field of economic uncertainty provide good background.

A recent innovative work develops metrics to quantify geopolitical risk (GPR) using newspaper citations and develops GPR indices of increasing specificity for the world, specific countries, specific industries, and specific firms. They define geopolitical risk as "the threat, realization, and escalation of adverse events associated with wars, terrorism, and any tensions among states and political actors that affect the peaceful course of international relations." Considering the ADDAPT approach (Rungtusanatham and Johnston, 2022), this work would fit with the detection and diagnosis of a disruption.

Caldara and Iacoviello (2022) note that the three largest spikes since 1985 resulted from the Gulf War, 9/11, and the 2003 invasion of Iraq. More recent triggers include the Paris terrorist attacks and the North Korean crisis in 2017–8, while historical triggers include the start of both world wars, D-Day, the Korean War, and the Cuban missile crisis. Moreover, they provide eight categories of adverse geopolitical events: (1) War threats (e.g., Germany invaded Czechoslovakia in 1938), (2) Peace threats (e.g., Iran crisis of 1946), (3) Military buildup (e.g., the Cuban missile crisis of 1962), (4) Nuclear threats (e.g., Nuclear ban negotiations of August 1963), (5) Terrorist threats (e.g., 9/11 in 2001), (6) Beginning of war (e.g., WWII begins in 1939), (7) Escalation of war (e.g. D-Day in 1944), and (8) Terrorist acts (e.g. 9/11 in 2001).

One can note that there is some redundancy in these categories. Considering their second and third categories provides an illustrative example of the overlap. The second category of "peace threats" searches for (variations of) peace and disruption words, while the third category, "military buildup," looks for (variations of) military and buildup, even though it is clear that the same event might well belong in both categories. This can be explained by the fact that in their work, the authors developed and utilized search string combinations for each category to identify and isolate contributions to geopolitical risk.

A recent work used the context of the recent scarcity of semiconductors to illustrate new facets of geopolitical risk (Lee and Glosserman, 2022). Semiconductors are essential in the manufacture of many products, appliances, automobiles, as well as computer and weapon systems. The authors refer to this as the new national security economy, where dependency on foreign production capacity can itself present a national security risk. In their work, they are more concerned with the economic conflict between countries, as manifested in tariffs and trade barriers that affect global supply chains, rather than conflicts with actual physical violence, though they clearly draw a connection between the two. As such, economic conflict and not merely violent conflict should be included in any discussion of geopolitical risk in supply chains.

The background allows us to conclude that there is an opportunity to conduct a literature review to address some of the incomplete aspects from previous literature, being (i) the identification of the main disruptions of supply chains due to geopolitical reasons, (ii) a new classification of such disruptions with no overlaps; (iii) the identification of their effects; and (iv) the identification of the strategies, actions or mechanisms to overcome or mitigate them to decrease the severity of the effects.

3. Methodology

The main purpose of this research is to provide a comprehensive analysis of the main disruptions of supply chains due to

geopolitical reasons, the effects of the disruptions, as well as any supply chain decisions to mitigate the severity of their impact. This research also aims to identify the main future research directions about the topic. Fig. 1 provides a research reference model designed according to the research questions.

With the aim of answering these research questions in mind, this study carried out an SLR. This is a structured method that strives to comprehensively identify, search, screen, collect, summarize, and synthesize all the relevant studies and empirical evidence on a specific topic (Greenhalgh et al., 2018; Higgins and Green, 2008; Petticrew and Roberts, 2006), being its main key characteristics: "a clearly stated set of objectives with pre-defined eligibility criteria for studies; an explicit, reproducible methodology; a systematic search that attempts to identify all studies that would meet the eligibility criteria; an assessment of the validity of the findings of the included studies, for example through the assessment of the risk of bias; and a systematic presentation, and synthesis, of the characteristics and findings of the included studies" (Higgins and Green, 2008).

This SLR consisted of two stages, which correspond to an adaptation from (Denyer et al., 2003). In the first stage, the articles were selected following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) standard (Page et al., 2021). In the second stage, the data from the pool of selected articles were extracted, synthesized, and analyzed by applying a content analysis (Seuring and Gold, 2012). Both stages are explained below.

3.1. *Literature selection strategy*

A rigorous and systematic literature selection strategy has been developed to ensure transparency, rigor, and generalizability in the inclusion of relevant academic articles and the exclusion of irrelevant ones. This strategy has been designed according to the PRISMA standard, which is designed to help authors document and justify transparently and clearly the steps to conduct an SLR (McGuinness et al., 2021; Page et al., 2021). Accordingly, the literature selection stage consisted of four steps: identification, screening, eligibility, and final exclusion/inclusion.

4. Step 1: Identification

A crucial aspect in implementing the PRISMA protocol is selecting the primary data source database. We chose Scopus as the database for extracting the publication corpus in our SLR. This decision was influenced by several reasons. Firstly, it is renowned as the leading database in academic literature, being the largest for abstracts and citations in reputed journals (Fahim and Mahadi, 2022; Lagorio et al., 2022). In fact, Scopus provides a more extensive and multidisciplinary coverage of scientific journals, about 60 % more than Web of Science (WoS) (Elnadi and Abdallah, 2024; Mariani and Borghi, 2019). It brings together well-known publishers like Science Direct, Willey, Emerald, Springer, and Taylor and Francis, thereby ensuring inclusiveness and robustness of findings (Zupic and Čater, 2015). Secondly, Scopus includes only high-quality, peer-reviewed publications, ensuring both indexing and reliability of findings (Ed-Dafali et al., 2025). Consequently, additional quality filters, like checking journal rankings, are unnecessary. Thirdly, unlike WoS and Scopus, Google Scholar (GS) lacks a user application programming interface for reviewing and exporting reference lists to reference manager software (Zupic and Čater, 2015). Fourthly, utilizing multiple databases can complicate data integration and make data homogenization challenging (Galati and Bigliardi, 2019; Mariani and Borghi, 2019). Lastly, choosing only Scopus is also consistent with recent SLRs on supply chain managements in prestigious journals with high quality standards, such as Transportation Research Part E (Govindan et al., 2022), Business Strategy and the Environment (Ed-Dafali et al., 2025; Negri et al., 2021), International Journal of Logistics: Research and Applications (Han et al., 2024; Lagorio et al., 2022), among others. To verify the inclusivity and robustness of findings using only Scopus in the context of geopolitical disruptions in supply chains, searches with the same keywords were conducted in WoS, as suggested by Mariani and Borghi (2019). The comparison showed that Scopus consistently retrieved more articles than WoS, thus confirming Scopus was the right choice.

The search was initially conducted in July 2023 and updated in March 2025 to avoid missing recent developments in geopolitical supply chain disruptions. The timeframe introduced in the database covers all published articles up to and including 2024. Thus, we sought to explore the progress made on geopolitical supply chain disruptions until the new geopolitical scenario that emerged with Trump's second term as President of the United States.

In order to achieve a comprehensive review of the literature, a set of keywords needed to be developed to guide the search. This is a

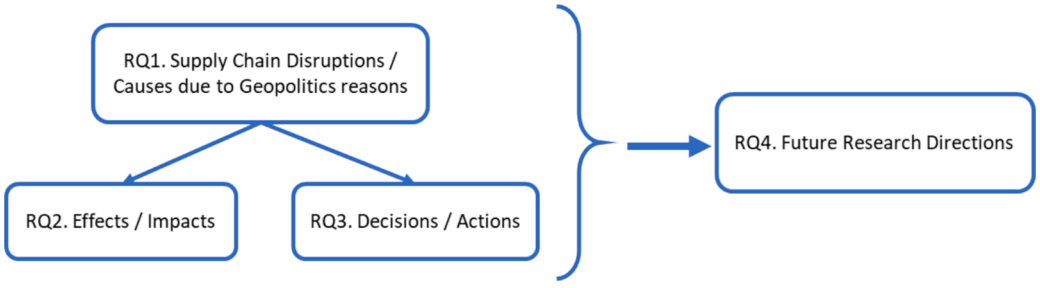

Fig. 1. Research reference model.

critical preliminary step, as a robust set of keywords will result in an inclusive list of references for the field. Conversely, a less carefully considered set of keywords will likely omit key contributions to the topic, adversely impacting both the list of references as well as the interpretation of the results and the resulting impact of the study. Given its importance, we approached the keyword strategy considering a relevant systematic review protocol (Ali et al., 2023).

The process for defining the set of keywords started by first considering the RQs, and three sets of keywords were considered: the first related to supply chain, the second to geopolitics, and the third to disruption. The set "supply chain resilience" was omitted in order to avoid limiting the identified articles in the SLR to those that address the management of geopolitical disruptions in supply chains from a resilient perspective.

Each of these sets was then subjected to a process consisting of several steps. First, we reviewed previous articles on geopolitical supply chain disruptions to incorporate multiple synonyms and alternative phrasing. Second, we carried out a brainstorming session to define and refine the search query. One of the participants has an extensive business background, incorporating specific industrial terminology into the assessment. Third, several iterations were conducted with the aim of refining and optimizing the process of identifying all the relevant keywords. The refining iterative process consisted of checking the results and conducting new searches, incorporating or deleting synonyms, truncations, boolean operators, and controlled vocabulary specific to the selected database. For example, the term "armed conflict*" was dropped due to its inclusion did not identify any additional articles. Other terms, such as "tariff" or "trade", were excluded because they generated noise by yielding a large number of articles unrelated to geopolitics. Finally, an expert panel specialized in bibliometric analysis from the research support unit validated the process to ensure completeness and accuracy of the research query.

We built the research query using a boolean search tactic with asterisk and proximity operators. Specifically, we combined the keywords within each set using the "OR" operator and the sets with the "AND" operator. Additionally, we added an asterisk * to the root of the keywords to enable the most extensive wildcard search possible, ensuring that no variations of key terms were overlooked. The first set introduces the focus of supply chain with the keywords "supply chain*" OR "supply network*". The second sets integrate the perspective of geopolitics using the keywords geopoliti* OR politic* OR war OR terrorism. The third set reflects the worlds related to disruptions disruption* OR risk* OR uncertain* OR shock* OR disturbance*. These descriptors were carefully selected, grouped, and optimized in an iterative process. We also added the proximity operator W/5 to optimize the search, ensuring that the key terms within each set were no more than 5 words in distance in the abstract.

Thus, the final search query resulted in the following:

(TITLE-ABS-KEY (("supply chain*" OR "supply network*")) AND TITLE-ABS-KEY ((geopoliti* OR politic* OR war OR terrorism)) AND TITLE-ABS-KEY ((disruption* OR risk* OR uncertain* OR shock* OR disturbance*)) AND ABS (("supply chain*" OR "supply network*") W/5 (geopoliti* OR politic* OR war OR terrorism)) OR ABS (("supply chain*" OR "supply network*") W/5 (disruption* OR risk* OR uncertain* OR shock* OR disturbance*)) OR ABS ((geopoliti* OR politic* OR war OR terrorism) W/5 (disruption* OR risk* OR uncertain* OR shock* OR disturbance*))).

The final search query provided the Identification of 1162 articles. (n = 1162).

5. Step 2: Screening

The next step consisted of screening the n = 1162 articles. The first exclusion criteria during screening are that we only consider articles written in English (n = 1124); then, we only consider academic articles published in a journal (n = 734). Then, we decided to exclude the articles not belonging to the subject areas: "Social Sciences", "Business, Management and Accounting", "Economics, Econometrics and Finance", "Engineering," and "Decision Sciences". Since the search aimed to identify the largest possible number of articles to carry out a comprehensive and exhaustive SLR, the journals were not limited by any quality criteria [i.e., inclusion of the journal in widely recognized rankings such as the Journal Citation Reports (JCR) or the Association of Business Schools (ABS) Academic Journal Guide (AJG). Thus, no topically relevant articles were excluded from the search. The final search resulted in n = 602 articles.

6. Step 3: Eligibility

The revision of the 602 articles identified during the screening process involved the participation of researchers in Steps 3 and 4. To minimize potential errors, four researchers participated in four iterative rounds. This did not imply that all researchers reviewed all articles across all rounds, as the process was designed to prevent fatigue among them. In addition, work schedules were jointly agreed

Table 1
Task distributions among researchers.

	1st round (step 3)	2nd round (step 3)	3rd round (step 3)	4th round (step 4)
Researcher 1	301	46	17	65
Researcher 2	301	48	17	65
Researcher 3	301	36	17	–
Researcher 4	301	34	17	–
Task	Title and abstract only	Title and abstract only	Full article	Full article
Article assignment	Randomly	The same	Randomly	Randomly
Selected articles (n)	251	184	130	69

upon Table 1 summarizes the number of articles reviewed in each round by each researcher, along with the task assignments and the number of articles moving to the next round.

In the first round, each article was randomly assigned to a pair of researchers for title and abstract revision. They individually reported if the article should be accepted (marked "green") or rejected (marked "red") based on its ability to respond to the RQ. The first round concluded with a report summarizing the degree of agreement by the two assigned researchers, i.e., identifying the number of cases where the two of them (i) agreed on their acceptance, (ii) agreed on their rejection, and (iii) showed discrepancies. After the first round, we considered 251 articles (n = 251).

In the second round, researchers only rechecked again the title and abstract of the articles they had reviewed in the first round, where discrepancies were identified. After the second round, we considered 184 articles (n = 184). In a third round, a different researcher resolved the discrepancies that persisted after the initial reviews. After the third round, we considered 130 articles (n = 130).

7. Step 4: Final Exclusion/Inclusion

The fourth round was conducted by two researchers who fully checked all the accepted articles to confirm. During this last step, some new exclusion criteria were considered, being: (i) if the article refers to disruption risks in general. For example, Zhang et al. (2022) explored how business competition resulting from tariff increases can affect companies. However, it does not specify whether the tariff increase stems from geopolitical disruptions. (ii) if the article mentions geopolitical reasons (among others) for disruptions but does not specify clear effects and actions related to them. For example, Dong et al. (2022) did not provide concrete managerial decisions to mitigate disruptive effects derived from politician turnover. (iii) disruptions whose main and primary cause is Covid19. For example, Clottey and Benton (2024) studied the chip shortage as collateral damage from the covid19. Thus, the 130 papers were fully read and after the fourth round, we considered 69 articles (n = 69).

Some inclusion criteria were also considered, and they referred mainly to the manner in which new articles responded to the RQ, overcoming some search limitations in keyword selection. A cross-reference and a snowballing analysis allowed the identification and inclusion of 11 new articles, making the final database for this research composed of n = 80 papers. Fig. 2 presents the search process.

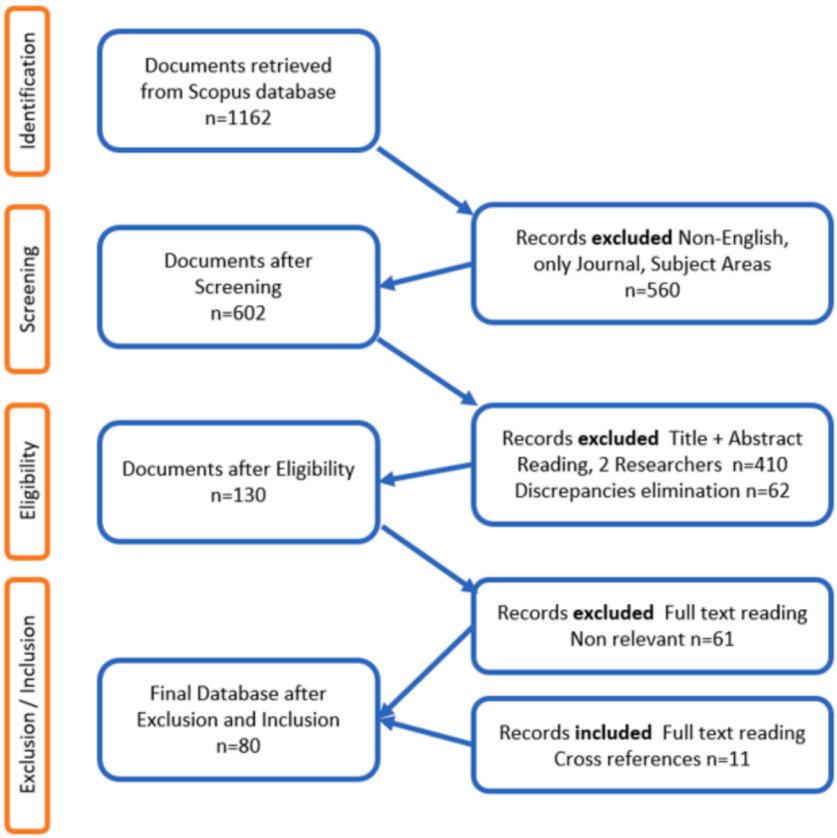

Fig. 2. Search process based on the PRISMA method.

7.1. Content analysis

Content analysis is defined as "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use" (Krippendorff, 2004). To answer the RQ in mind, this analytical technique was applied to extract, organize, and analyze the data from the 80 articles identified in the previous stage. In this way, we followed the four proposed steps (Mayring, 2004). Step 1 was completed in the previous stage, where we delimited the articles to be assessed. Additionally, we defined the supply chain as the unit of analysis. Step 2 involved a descriptive analysis of the 80 articles identified, following the PRISMA standard (Page et al., 2021). Specifically, we examined the distribution of journals, research methods, and the number of publications by year. Step 3 established the dimensions for extracting, codifying, and organizing the content to be analyzed. In order to guarantee the reliability and validity of content analysis, we adhered to the recommendations made by (Seuring and Gold, 2012). In doing so, we carried out three rounds of codification. In the first round, four researchers individually coded the information extracted from each article randomly assigned. In the second round, these codifications were reviewed by two of the researchers in several virtual meetings. In the third round, a single coder unified the terms and definitions employed in this labor and generated a table for each type of geopolitical disruption affecting the supply chain identified in the content analysis. Unclear contents were asked of the researchers who had previously extracted and coded them. Inter-code reliability was thus pursued by reviewing, aligning, and recoding divergent interpretations of constructs between participant researchers. Another coder independently coded a randomly selected sample of recorded units to determine the grade of inter-code reliability and consistency (Tangpong, 2011). The result of calculating the Cohen's kappa reliability indicator was 0.796, which indicates a substantial agreement between the two coders (Landis and Koch, 1977). The article provides a supplementary file containing the detailed coding procedures and reliability analysis. It highlights the consistency and reliability of the coding process. Finally, step 4 assessed content to answer the research questions. In doing so, a table was generated for each type of geopolitical disruption in the supply chain. The final tables are also included as supplementary material.

7.2. Generating and interpreting models

We developed a model for each geopolitical disruption, considering the disruptive effects and their corresponding managerial supply chain decisions, as identified in the final tables from step 4 (supplementary material). Each model includes a red node representing a geopolitical disruption. The yellow nodes indicate the disruptive effects in the supply chain, while the white nodes show the managerial supply chain decisions made to resist, mitigate, and overcome them. The arrows represent the relationships between nodes. These were identified in the final tables from step 4 (supplementary material), considering disruptive effects and the corresponding strategic, tactical, or operative decisions identified in each article. For example, in the geopolitical disruptions GD1_Political instability, uncertainty surrounding transactions was mitigated by contracting insurance on political risk and investment (PRI) (Rayman-Bacchus and Webb, 2012). Fig. 3 shows an example. It indicates that the geopolitical disruption provoked four disruptive effects. Supply chain decision 1 was adopted to mitigate disruptive effects 1, 2, and 3. Disruptive effect 4 was mitigated by adopting either supply chain decision 2 or 3. Therefore, all disruptive effects would be mitigated by adopting supply chain decision 1 with supply chain decision 2 or supply chain decision 1 with supply chain decision 3.

8. Descriptive analysis

This section presents a summary of descriptive statistics of the 60 reviewed papers, including the journal distribution, the research methods, and the number of publications by year.

8.1. Descriptive analysis of journal contributions

The 80 papers in our sample have been published in different journals, as shown in Table 2 below. The most contributing journal in our study was *International Journal of Operations and Production Management* (9 papers), followed by *Transportation Research Part E* (6 papers), *Journal of Operations Management* (4 papers), and then by three other journals (*International Journal of Logistics Research and Applications, Supply Chain Management: an International Journal, Journal of Cleaner Production*) contributing each of them with three papers. These six journals account for 35 % of the articles reviewed; the remaining 65 % corresponds to other journals contributing less

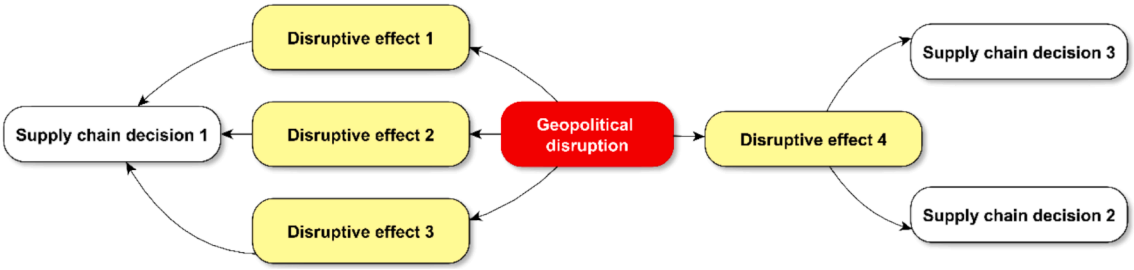

Fig. 3. An example of a geopolitical disruption model.

Table 2
Journals/articles distribution.

JOURNAL	Nr. articles	%
International Journal of Operations and Production Management	9	11,3%
Transportation Research Part E	6	7,5%
Journal of Operations Management	4	5,0%
International Journal of Logistics Research and Applications	3	3,8%
Supply Chain Management: an International Journal	3	3,8%
Journal of Cleaner Production	3	3,8%
International Journal of Supply Chain Management	2	2,5%
Resources Policy	2	2,5%
Sustainability	2	2,5%
Computers & Industrial Engineering	2	2,5%
Others	44	55,0%
TOTAL	**80**	100,0%

than two papers. The total number of journals is 57, which shows a wide dispersion. Most of the journals (25) are related to the disciplines of operations and supply chain management. The selected journals belong to other disciplines, such as technology (8), science and energy (7), specific sectors such as food or maritime (6), other management areas (6), and multidisciplinary journals (5), among others.

8.2. Methodological approaches

The papers subject to this study have been classified into two main types or categories (Empirical or Theoretical) according to the methodological approach adopted. Then, Empirical papers have been grouped into Quantitative (simulations, surveys and questionnaires, model-based analyses, etc.), Qualitative (case studies, interviews, secondary sources, Delphi method, etc.), or Mixed Methods papers (a combination of the previously mentioned methods). On the other hand, Theoretical papers have been grouped into two subcategories: Concept development and Literature review.

Table 3 below provides all the details about the methodological distribution of papers. Regarding the paper types adopted among the 80 papers analyzed, the most commonly used were Empirical papers with 60 publications, representing 75 % of all the papers. Among Empirical papers, a high majority (34 papers, 42.5 % of the total) follow a Quantitative approach, while 19 papers (23.8 %) follow a Qualitative approach, and just seven papers (8.3 % of the total) follow a Mixed Methods approach. Then, Theoretical papers represent 20 articles (25 % of the total). Concept development seems to be the most common Theoretical approach as it has been followed in 16 articles (20 % of the total), while the Literature review approach has been adopted in four papers (5 % of the total).

8.3. Distribution of articles per year across the period studied

Fig. 4 presents the annual production of papers across the period studied (between 2000 and 2024). As shown in Fig. 4, the first article was published in 2003. From 2000 to 2011, research on this topic was scarce, as only three papers were published in 2003, 2009, and 2011. The research topic gained some interest from 2012 to 2018, as an average of 2.7 papers per year were published. The topic gained significant attention during the last six years, when at least five papers per year were published, reaching a maximum of sixteen papers in 2024. These data show that there is an increasing academic interest in this research topic.

9. Findings

9.1. Geopolitical supply chain disruptions in the literature

Geopolitical supply chain disruptions refer to territorial and political tensions occurring within a country (which we refer to as

Table 3
Methodological approaches distribution.

Paper type	Method	Total	Percentage
Empirical			
	Quantitative	34	42,5%
	Qualitative	19	23,8%
	Mixed Methods	7	8,8%
	Total	60	75,0%
Theoretical			
	Concept development	16	20,0%
	Literature review	4	5,0%
	Total	20	25,0%
	Overall total	80	100,0%

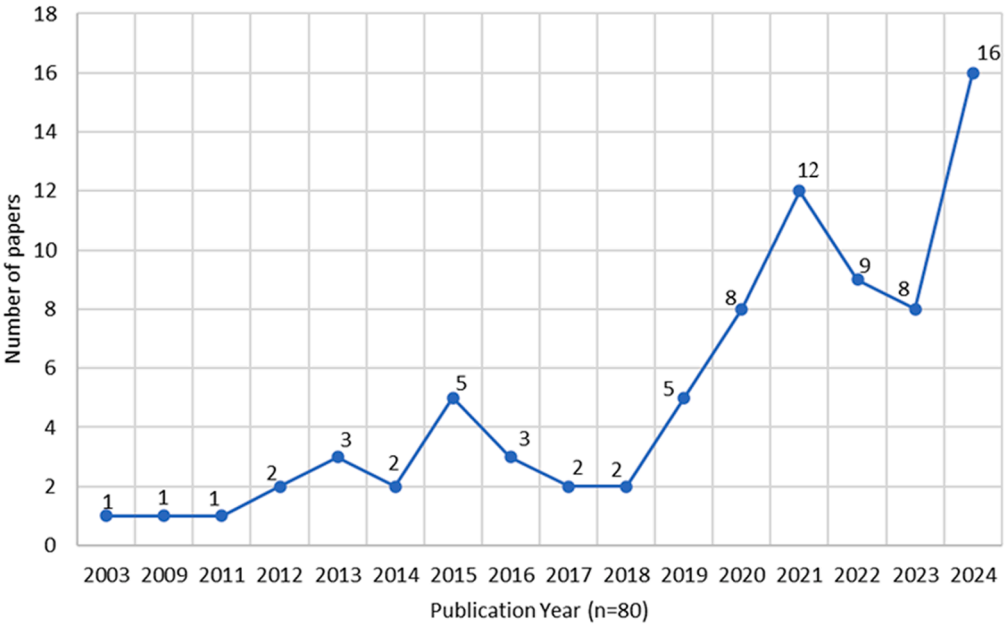

Fig. 4. Distribution of papers per year.

internal) or between countries or regions (referred to as external), leading to sudden interruptions, failures, or alterations in supply chain activities. These high-impact disruptions arise from unusual human-made actions outside the scope of the supply chain and, thereby, have been considered macro-risks or environmental risks (Ho et al., 2015; Shekarian and Mellat Parast, 2021). Despite significant advances that have been carried out in the literature, few articles delineate some geopolitical disruptions (Bednarski et al., 2023; Caldara and Iacoviello, 2022). For example, Hu et al. (2023) solely identifies sovereign, military, and major power intervention as geopolitical risk types along the Belt and Road. However, the identification of geopolitical disruption types is vital for gaining a better understanding of their adverse effects and determining the strategic, tactical, and operational actions required to manage them successfully. Upon finishing the content analysis of every article gathered in the SLR, we organized the data regarding the causes of supply chain disruptions caused by geopolitical events in each study. We meticulously examined these causes to pinpoint pertinent types of geopolitical disruptions, guaranteeing they are comprehensive so that all articles are classified, consistent across different contexts, and straightforward for use in future research. Table 4 illustrates the six types of geopolitical disruption identified in the

Table 4
Types of geopolitical disruptions.

ID	Types of geopolitical disruptions	References
GD1	Internal tension due to internal political instability	(Asif et al., 2019; Cimprich et al., 2019; Cordell et al., 2015; Elzarka, 2013; Geng et al., 2017; Huang et al., 2021; Kaitibie et al., 2019; Kauppi et al., 2016; Kovács and Falagara Sigala, 2021; Len, 2015; Lun et al., 2011; Mithun Ali et al., 2021; Pasternak and Dafnos, 2018; Provost et al., 2022; Rabbani et al., 2015; Rayman-Bacchus and Webb, 2012; Shanker et al., 2021)
GD2	Tensions between countries without direct economic or armed conflict	(Althaf and Babbitt, 2021; Charpin et al., 2021; Charpin and Cousineau, 2024; Fernández-Miguel et al., 2022; Huang et al., 2021; Kotcharin and Maneenop, 2020; Ren et al., 2024; Thapalia et al., 2009; Tukamuhabwa et al., 2017; Zhang and Bai, 2020; Zhou et al., 2023)
GD3	Internal or external tension due to piracy or terrorism	(Aggarwal and Bohinc, 2012; Bueno-Solano and Cedillo-Campos, 2014; Geng et al., 2017; Katri Kauppi et al., 2016; Li et al., 2022; Russell and Saldanha, 2003; Tan et al., 2024; Urciuoli et al., 2014; Voss and Williams, 2013; Xu et al., 2016; Zhang and Bai, 2020)
GD4	Tensions between countries with economic conflict but not armed conflict	(Asian et al., 2020; Blessley and Mudambi, 2022; Remi Charpin et al., 2021; Cohen and Rogers, 2021; Davarzani et al., 2015; Fan et al., 2022, 2024; Gong et al., 2020; Grosse et al., 2021; Handfield et al., 2020; Jacobs et al., 2022; Johnson and Haug, 2021; Lam et al., 2022; Li et al., 2022; Liu et al., 2023; Moradlou et al., 2024; Song et al., 2022; Tse et al., 2024; Zhang et al., 2024)
GD5	Internal tension due to independence and dependence	(Charpin, 2022; Handfield et al., 2020; Johnson and Haug, 2021; Moradlou et al., 2024, 2021)
GD6	Tensions between countries with both economic and armed conflict	(Al-Douri, 2018; Altuntas Vural et al., 2024; Belhadi et al., 2024a; Ben Hassen and El Bilali, 2022; Böcher et al., 2024; Charpin et al., 2021; Duong et al., 2024; Erol, 2024; Galanakis, 2023; Jola-Sanchez and Serpa, 2021; Krykavskyy et al., 2023; Kumar et al., 2023; Min, 2022; Rahbari et al., 2024; Roy et al., 2024; Srai et al., 2023; Tsang et al., 2024; Waldl et al., 2024)
	Multiple geopolitical disruptions	(Abdellaoui and Pache, 2019; Bhattacharya et al., 2013; Chukwuka et al., 2023; Farrukh and Sajjad, 2024; Helbig et al., 2016; Hsu et al., 2021; Marten and Atalan-Helicke, 2015; Nimsai and Siriyod, 2019; Zhao et al., 2020)

study. These are described below:

- **Internal tension due to internal political instability (GD1)**: geopolitical events derived from internal political instability in a country where uncertainty breeds ethnic, religious, labor-related conflicts, and even economic crises. This group would also include domestic geopolitical disruptions. Among the causes that trigger them are tensions between ethnic or religious groups, social tensions due to disparity or economic crises, lack of democracy, corruption, institutional instability, and frequent or abrupt changes in government, among others.
- **Tensions between countries without direct economic or armed conflict (GD2)**: geopolitical events derived from tensions between countries to preserve national sovereignty that initially do not lead to economic or armed conflict. Here, the tension between countries is not directly intended but a result of one or both responding to something affecting one or both of the state actors. A good example here would be the disruption in supply chains as the Covid pandemic unfolded around the globe, which unintentionally complicated trade between nations as they responded dynamically to the virus.
- **Internal or external tension due to piracy or terrorism (GD3)**: geopolitical events derived from terrorist attacks or pirate assaults carried out by armed groups due to religious, economic, or other motives. Here, non-state actors rather than either internal political forces or other (state actors) countries are the source of the disruption. This group would include e.g. Somali pirates, Houthi rebels, 9/11, and so on.
- **Tensions between countries with economic conflict but not armed conflict (GD4)**: Geopolitical events derived from tensions between countries to preserve economic sovereignty, leading to government-imposed trade barriers, quotas, tariffs, or other commercial restrictions. Here, there is economic tension between nation states, manifesting itself in various protectionist mechanisms, but not armed conflict or violence between the two nation states. The recent discussion of tariffs between the US, Canada, and Mexico provides a good example of this group, and there are others.

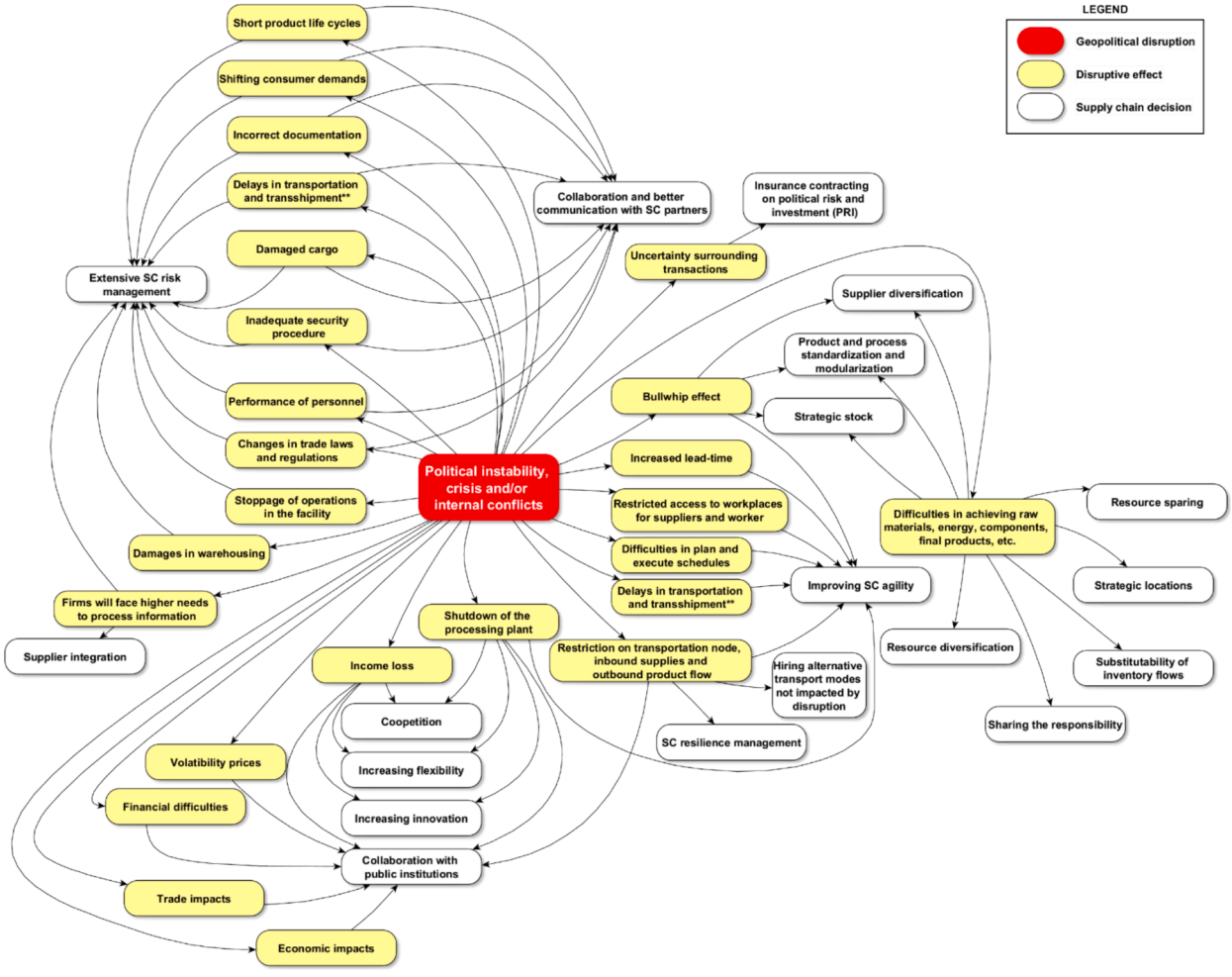

Fig. 5. Model on supply chain management in case of political instability, crisis, and/or internal conflicts.

- **Internal tension due to independence and dependence (GD5)**: geopolitical events derived from political and social movements aimed at bolstering the identity, culture, and interests of a specific region (i.e., EU) or nation through either independence from supranational entities or the adoption of more stringent laws and policies. Here, the disruption is caused by one geographic area being suddenly subject to or not subject to laws of a surrounding or adjacent geographic area. The exit of Great Britain from the European Union (i.e. Brexit) is a good example of this group, among others.
- **Tensions between countries with both economic and armed conflict (GD6)**: Geopolitical events derived from tensions between countries to preserve territorial sovereignty and national security, leading to armed conflicts between armies. Here, the presence of armed conflict between nations and groups of nations is characteristic, whether actually a declared war or not. This group would include disruptions due to the Russia Ukraine conflict, Isreal Hamas conflict, and the like.

While these groupings classify the cause or reason for the geopolitical disturbance, it should be noted that certain geopolitical disruptions are closely interrelated, and one type may either coincide with or cause another type to occur. Consequently, several articles examined the simultaneous occurrence of multiple geopolitical disruptions. Articles analyzing at least three geopolitical disruptions concurrently were categorized under "Multiple geopolitical disruptions.".

9.2. Modelling the progress on political instability, crisis, and internal conflicts in supply chain management (GD1)

The articles analyzing this geopolitical disruption span a time horizon between 2012 and 2022. The geographical areas over which conflicts were examined are located in South Asia (Asif et al., 2019; Mithun Ali et al., 2021; Shanker et al., 2021), East Asia (Geng et al., 2017; Len, 2015), the Middle East (Kaitibie et al., 2019), North America (Pasternak and Dafnos, 2018), Europe (Cimprich et al., 2019; Rabbani et al., 2015), North and Central Africa (Cordell et al., 2015; Elzarka, 2013; Provost et al., 2022). The sectors whose supply chains have been affected by this geopolitical disruption include mining (Rayman-Bacchus and Webb, 2012), food (Kaitibie et al., 2019; Provost et al., 2022), energy (Len, 2015; Rabbani, Bahadornia, and Torabi, 2015; Geng et al., 2017), chemicals (Cordell, Turner and Chong, 2015; Pasternak and Dafnos, 2018; Huang et al., 2021), textiles (Asif et al., 2019; Mithun Ali et al., 2021), automobile manufacturing (Cimprich et al., 2019), retail and logistics (Elzarka, 2013; Lun et al., 2011; Shanker et al., 2021), among others.

Referring to the appendix, political instability, crises, and internal conflicts (GD1) caused 24 disruptive effects in supply chains (Appendix). These disrupted the material, monetary, and information flows of upstream and/or downstream parts of the supply chains analyzed in the literature. In some cases, GD1 led to a ripple effect across multiple agents in the supply chain (Asif et al., 2019; Cordell et al., 2015; Huang et al., 2021; Pasternak and Dafnos, 2018; Provost et al., 2022; Rayman-Bacchus and Webb, 2012). For example, the blockade of railway tracks by Indigenous activists in Canada (Pasternak and Dafnos, 2018) asserting their sovereignty resulted in a restriction on transportation nodes. This disruptive effect of inbound supplies and outbound product flow in the region's petrochemical industry jeopardized workers' employment and the propane supply for customers, among other effects.

Fig. 5 shows the effects of GD1 on the supply chain, together with the managerial decisions made to eliminate or mitigate these effects. Decisions that showed the greatest mitigation of disruptive effects were "Extensive SC risk management", "Collaboration and better communication with SC partners", "Collaboration with public institutions", and "Improving SC agility". These supply chain decisions eliminated or mitigated the effects of 11, 8, 7, and 7 disruptions, respectively. However, they did not mitigate all the potential effects of political instability disruptions. More specifically, the literature did not verify that these supply chain decisions mitigate the disruptive effects of "Difficulties in achieving raw materials, energy, components, final products, etc." and "Uncertainty surrounding transactions". The former can be mitigated by diversifying suppliers or applying another of the seven supply chain decisions identified in Fig. 5, while the latter can be mitigated by contracting an insurance contract on political risk and investment (PRI). Therefore, a strategy can be devised to minimize all potential effects of political instability disruptions more effectively. This strategy would integrate comprehensive supply chain risk management, collaboration, and better communication with SC partners and public institutions, supplier diversification, political risk insurance contracting, and investment decisions aimed at improving supply chain agility.

9.3. Modelling the progress on political tensions between countries in supply chain management (GD2)

The time horizon spans from 2009 to 2024, with the conflicts analyzed being located in East Asia (Zhang and Bai, 2020; Charpin et al., 2021; Zhou et al., 2023), South Asia (Thapalia et al., 2009), East Africa (Tukamuhabwa et al., 2017), Europe (Fernández-Miguel et al., 2022) and the Belt and Road Initiative (BRI) countries (Kotcharin and Maneenop, 2020). The sectors threatened by these political tensions between countries were energy (Thapalia et al., 2009; Zhang and Bai, 2020), chemicals (Huang et al., 2021), logistics (Kotcharin and Maneenop, 2020), manufacturing (Charpin and Cousineau, 2024), electronics (Althaf and Babbitt, 2021; Ren et al., 2024), ceramics (Fernández-Miguel et al., 2022) and leisure and travel (Zhou et al., 2023).

The literature identified 15 effects derived from political tensions between countries (GD2). These disrupted the material, monetary, and information flows of the upstream and/or downstream parts of the supply chains analyzed in the literature. GD2 also caused a ripple effect in some of the disrupted supply chains (Althaf and Babbitt, 2021; Huang et al., 2021; Kotcharin and Maneenop, 2020; Ren et al., 2024; Thapalia et al., 2009; Tukamuhabwa et al., 2017). For example, political tensions between the United States and China have provoked market uncertainty, making tungsten supply difficult. This supply disruption impacted the manufacturing industry's production, distributors, and customers (Huang et al., 2021).

Fig. 6 shows the model of supply chain decision to reduce and/or mitigate the disruptive effects derived from political tensions between countries. "Strategic stock", "Resource diversification", "Friendshoring, nearshoring and reshoring," and "Collaboration with

public institutions" achieved the most significant reduction in disruptive effects derived from GD2. To mitigate the disruptive effects identified in the literature more effectively, Fig. 6 highlights that managers would develop an integrative strategy comprising several management supply chain decisions: strategic stock, collaboration with public institutions, supply chain digitalization, and friend-shoring, nearshoring, and reshoring.

9.4. *Modelling the progress on terrorism and pirate attacks(GD3)*

The literature provides some advances in supply chain management in the context of terrorism and pirate attacks. These are modeled in Fig. 7. Notwithstanding, the number of articles identified on this geopolitical disruption is more limited compared to those addressing internal political instability and tensions between countries. These articles extend over a broad temporal horizon from 2003 to 2024. The analyzed terrorism and pirate attacks are located in Europe (Urciuoli et al., 2014), North America (Tan et al., 2024; Voss and Williams, 2013), Central America (Bueno-Solano and Cedillo-Campos, 2014), and East Asia (Geng et al., 2017; Zhang and Bai, 2020). Energy (Li et al., 2022; Urciuoli et al., 2014; Zhang and Bai, 2020) was the most studied sector under the effects of terrorist and pirate attacks, but maritime transportation (Geng et al., 2017), automotive industry (Bueno-Solano and Cedillo-Campos, 2014), and the assembly industry (Kauppi et al., 2016) were also examined.

The literature identified ten effects derived from terrorism and pirate attacks (GD3). These disrupted the material, monetary, and information flows of the upstream and/or downstream parts of the supply chains analyzed in the literature. GD3 did not lead to a ripple effect in the disrupted supply chains analyzed in the literature.

Fig. 7 presents the model of supply chain decision to reduce and/or mitigate the disruptive effects derived from GD3. "Strategic stock", "Supplier diversification," and "Collaboration with public institutions" were the most mitigated decisions. These mitigated 6, 4, and 4 disruptive effects, respectively. However, they are not enough to mitigate the increased need to process manufacturing firms' information due to the appearance of GD3 (Kauppi et al., 2016). With this in mind, managers would either improve supplier integration or perform extensive SC risk management. Therefore, the integrative strategy to manage GD3 would involve maintaining strategic stocks, supplier diversification, fostering collaboration with public institutions, better communication with customers, and implementing extensive supply chain risk management.

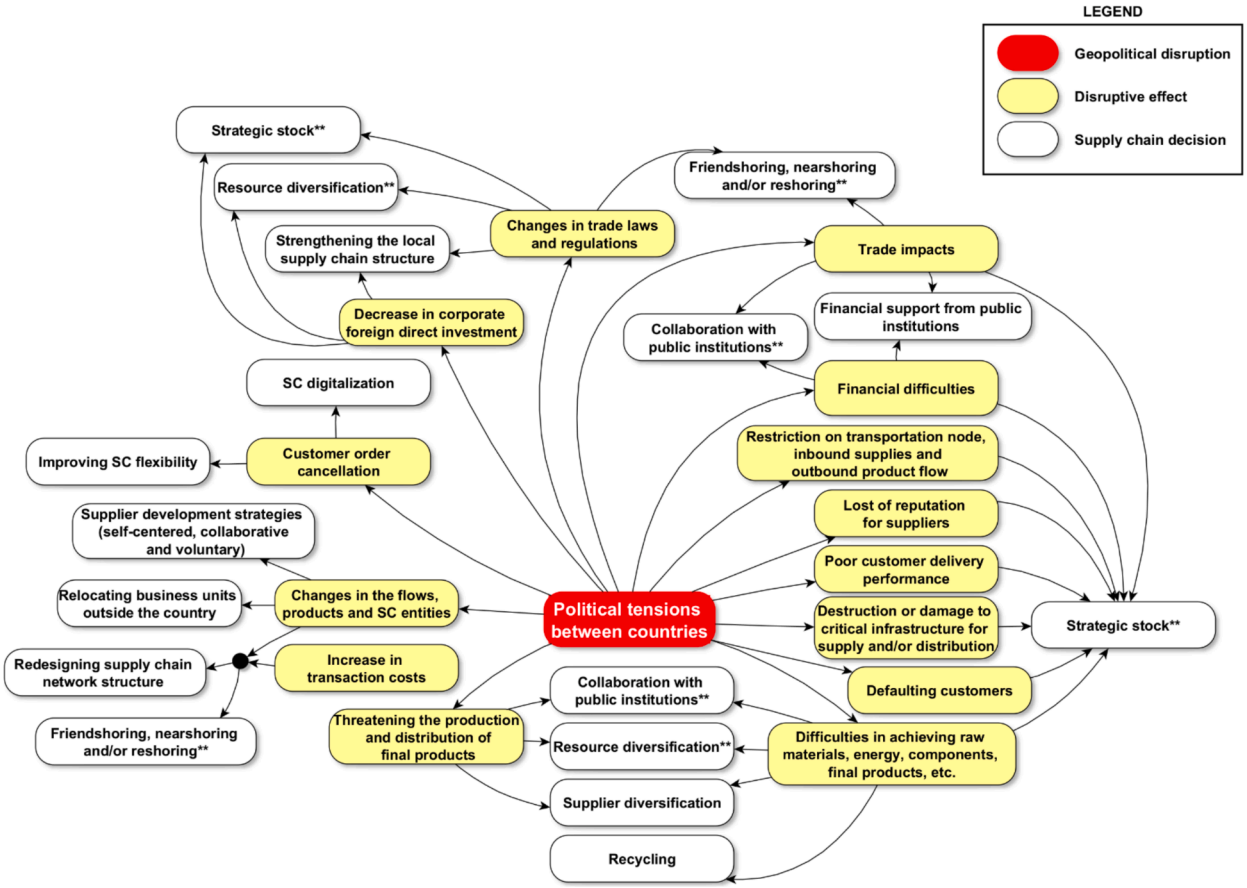

Fig. 6. Model on supply chain management in case of political tensions between countries.

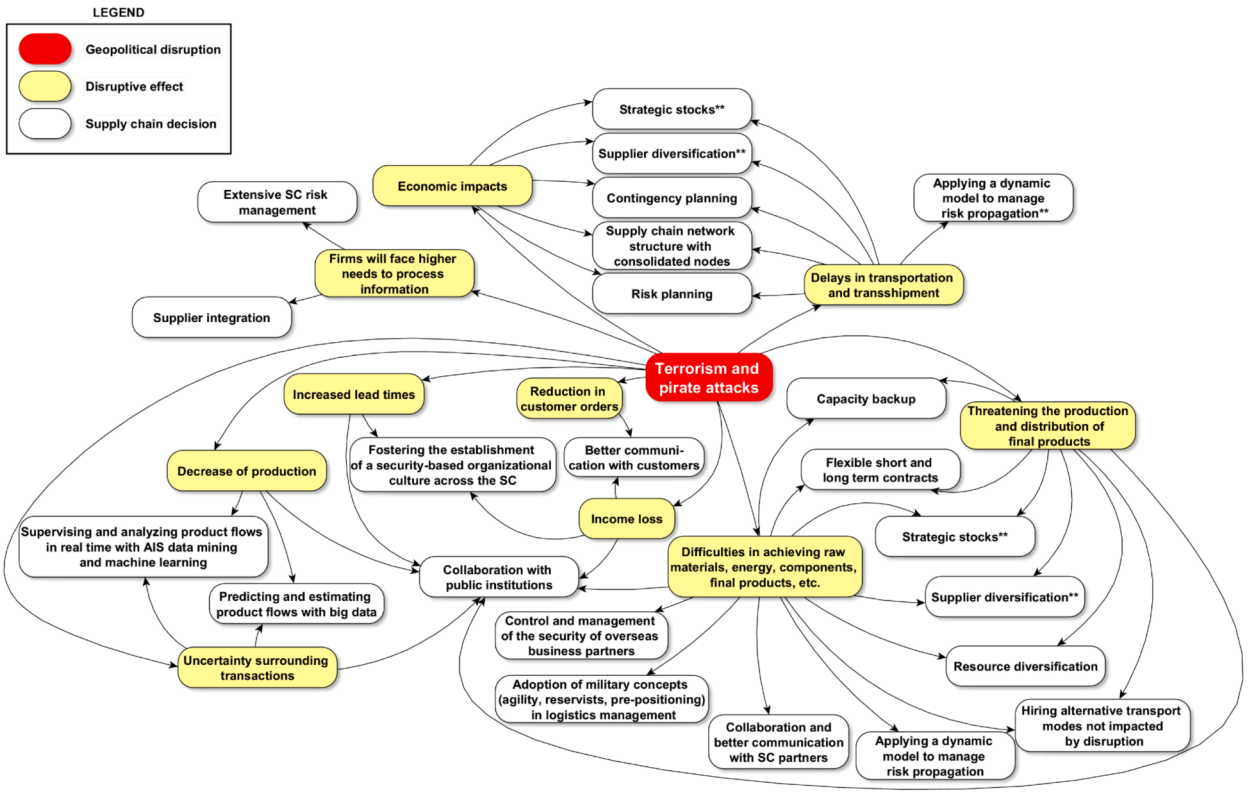

Fig. 7. Model on supply chain management in case of terrorism and pirate attacks.

9.5. *Modelling the progress on trade wars (GD4)*

The articles examining the supply chain management facing trade wars (GD4) span a time horizon between 2015 and 2024. The geographical areas over which this geopolitical disruption was studied are located in East Asia (Charpin et al., 2021; Fan et al., 2022, 2024; Grosse et al., 2021; Handfield et al., 2020; Jacobs et al., 2022; Liu et al., 2023; Tse et al., 2024; Zhang et al., 2024), North America (Blessley and Mudambi, 2022; Cohen and Rogers, 2021; Fan et al., 2022, 2024; Grosse et al., 2021; Handfield et al., 2020; Jacobs et al., 2022; Moradlou et al., 2024), the Middle East (Davarzani et al., 2015) and Europe (Handfield et al., 2020; Moradlou et al., 2024). Supply chains disrupted by trade wars and analyzed in the literature belong to logistics (Gong et al., 2020; Li et al., 2022), mining (Liu et al., 2023), food (Blessley and Mudambi, 2022), automobile manufacturing (Davarzani et al., 2015), patent-intensive industry (Cohen and Rogers, 2021), luxury sporting goods (Asian et al., 2020), semiconductor industry (Tse et al., 2024; Zhang et al., 2024), and telecommunications (Jacobs et al., 2022), among others.

GD4 caused 27 disruptive effects in supply chains (Fig. 8). These disrupted the material, monetary, and information flows of the upstream and/or downstream parts of the supply chains analyzed in the literature. The ripple effect cascaded through several supply chains as a consequence of GD4 (Blessley and Mudambi, 2022; Handfield et al., 2020; Jacobs et al., 2022; Johnson and Haug, 2021; Song et al., 2022; Tse et al., 2024). For example, due to the trade war between the United States and China during the previous Trump administration, the American food bank was overwhelmed with donations of agricultural products affected by Chinese tariffs, many of which were unusual. This severely negatively impacted the transportation, storage, and distribution of food managed through its supply chain (Blessley and Mudambi, 2022).

Fig. 8 shows the effects of trade wars on supply chains, together with the managerial decisions made to eliminate or mitigate these effects. “Redesigning the structure of the supply chain network”, “Strategy stock”, “Collaboration with the public institution”, “Collaboration and better communication with the SC partners” and “Relocation of business units outside of the country” were the supply chain decisions that eliminated or mitigated a higher number of effects with 10, 10, 6, 6 and 6, respectively. Additional supply chain decisions must be adopted to be able to mitigate all the potential effects of GD4. To jointly mitigate them, managers could undertake a strategy based on relocating and diversifying business units outside the country, improving collaboration with public institutions and SC partners, investing in operational slack and R&D capabilities, adopting a vertical integration strategy, maintaining a strategic stock, assessing potential stock market damage, preserving intellectual property, and redesigning the supply chain network structure.

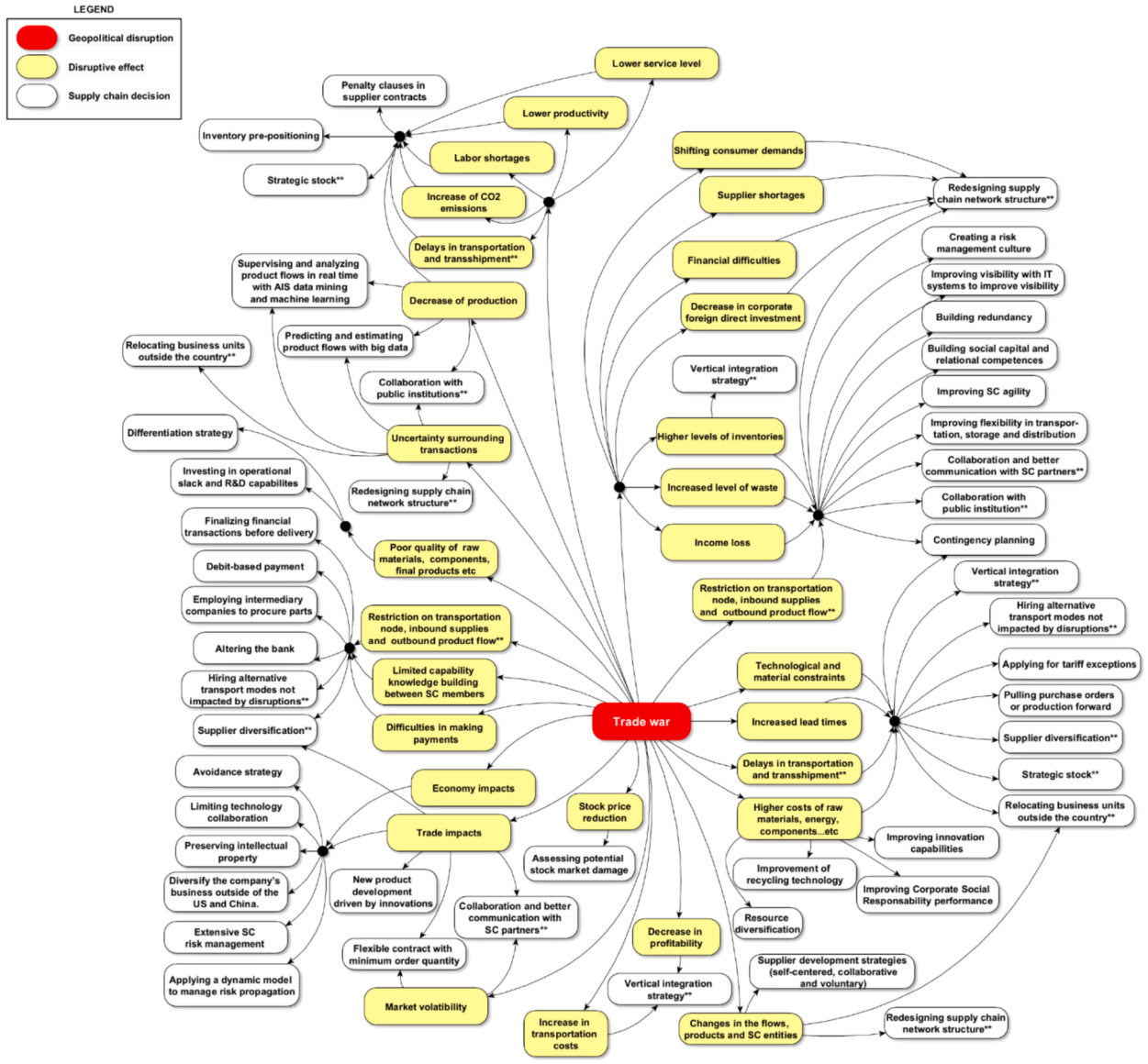

Fig. 8. Model on supply chain management in case of trade wars.

9.6. Modelling the progress on Brexit and other nationalist movements (GD5)

The sector threatened by Brexit and other nationalist movements (GD5) was manufacturing (Moradlou et al., 2021), among others. The time horizon spans from 2020 to 2024, with the conflicts analyzed being located in East Asia (Handfield et al., 2020), Europe (Handfield et al., 2020; Moradlou et al., 2021, 2024), and North America (Handfield et al., 2020; Moradlou et al., 2024).

Fig. 9 provides the model of the supply chain disruptions due to GD5. This contains 16 effects that disrupted the material, monetary, and information flows of the upstream and/or downstream parts of the supply chains analyzed in the literature. GD5 spread a ripple effect through supply chain members (Handfield et al., 2020; Johnson and Haug, 2021; Moradlou et al., 2021). For example, amid the uncertainty caused by Brexit regarding the movement of merchandise, companies in the pharmaceutical manufacturing, food, automotive, and aerospace industries had to adjust the sourcing and distribution areas of their supply chains (Moradlou et al., 2021).

Fig. 9 also shows the supply chain decision to reduce and/or mitigate the disruptive effects derived from GD5. "Strategic stock" and "Supplier diversification" mitigated the higher number of disruptive effects (10). However, further supply chain decisions are required to mitigate all disruptive effects. To effectively mitigate them, the model depicted in Fig. 9 suggests that implementing a tailored strategy comprising supplier diversification, redesigning the supply chain structure, and improving collaboration with supply chain partners should be performed to reinforce the supply chain-facing GD5.

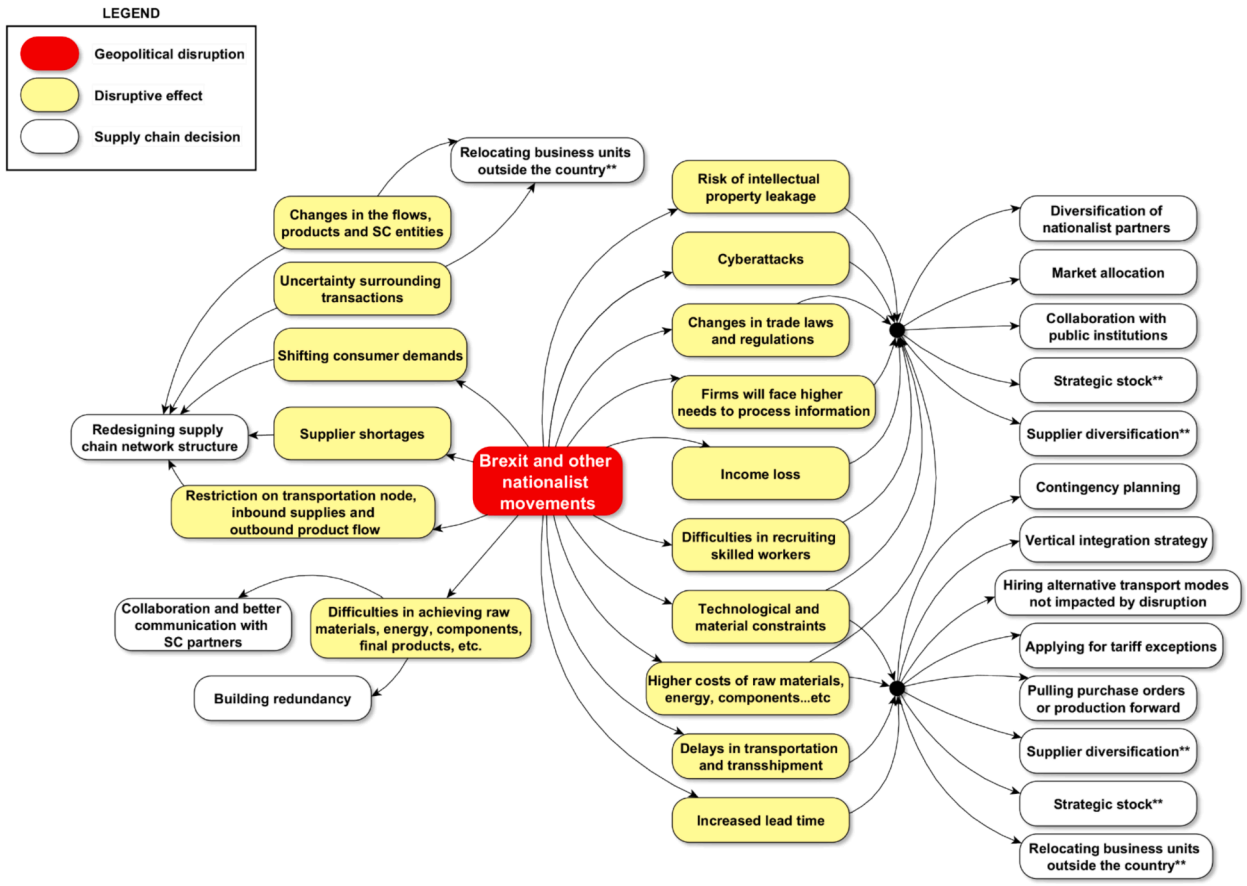

Fig. 9. Model on supply chain management in case of Brexit and other nationalist movements.

9.7. Modelling the progress on wars (armed conflicts) (GD6)

The ten articles identified in the literature on supply chain management facing wars *(armed conflicts) (GD6)* extend over a broad temporal horizon from 2018 to 2024. They analyzed wars and other armed conflicts located in Ukraine, Iraq, Iran, China, Mali, Afghanistan, and Colombia. Food (Altuntas Vural et al., 2024; Belhadi et al., 2024a; Ben Hassen and El Bilali, 2022; Galanakis, 2023; Jola-Sanchez and Serpa, 2021; Kumar et al., 2023; Rahbari et al., 2024; Waldl et al., 2024) was the most analyzed industry under the effects of this geopolitical disruption. Other sectors have also been studied in the literature, such as logistics (Erol, 2024; Krykavskyy et al., 2023), retail (Roy et al., 2024), semiconductor industry (Böcher et al., 2024), temporary healthcare (Duong et al., 2024), and energy (Al-Douri, 2018; Min, 2022), among others.

A total of 17 effects on the supply chain from GD6 were identified in the literature. These hindered the material, monetary, and information flows of the upstream and/or downstream parts of the supply chains analyzed in the literature. GD6 caused ripple effects across supply chain agents in some supply chains (Al-Douri, 2018; Altuntas Vural et al., 2024; Ben Hassen and El Bilali, 2022; Krykavskyy et al., 2023; Kumar et al., 2023; Min, 2022; Roy et al., 2024; Tsang et al., 2024; Waldl et al., 2024). For example, Russia's invasion of Ukraine destroyed, blocked, and damaged critical infrastructure for the supply and distribution operations of logistics firms, making it difficult for businesses to function normally (Krykavskyy et al., 2023).

Fig. 10 presents a model of the disruptive effects of GD6 as well as the managerial supply chain decisions adopted to mitigate them. "Collaboration with public institutions", "Capitalize on promising innovations" and "Invest in real-time analyses" were the supply chain decisions that eliminated or mitigated the highest number of effects. However, these supply chain decisions are insufficient to minimize all disruptive effects derived from GD6. The proposed model in Fig. 10 highlights that managers can develop an integrative strategy to minimize these effects more effectively. In doing so, they should progress toward a digitalized supply chain, invest in real-time analyses, build redundancy, hire alternative transport modes not impacted by disruption, and consider relocating business units outside affected countries.

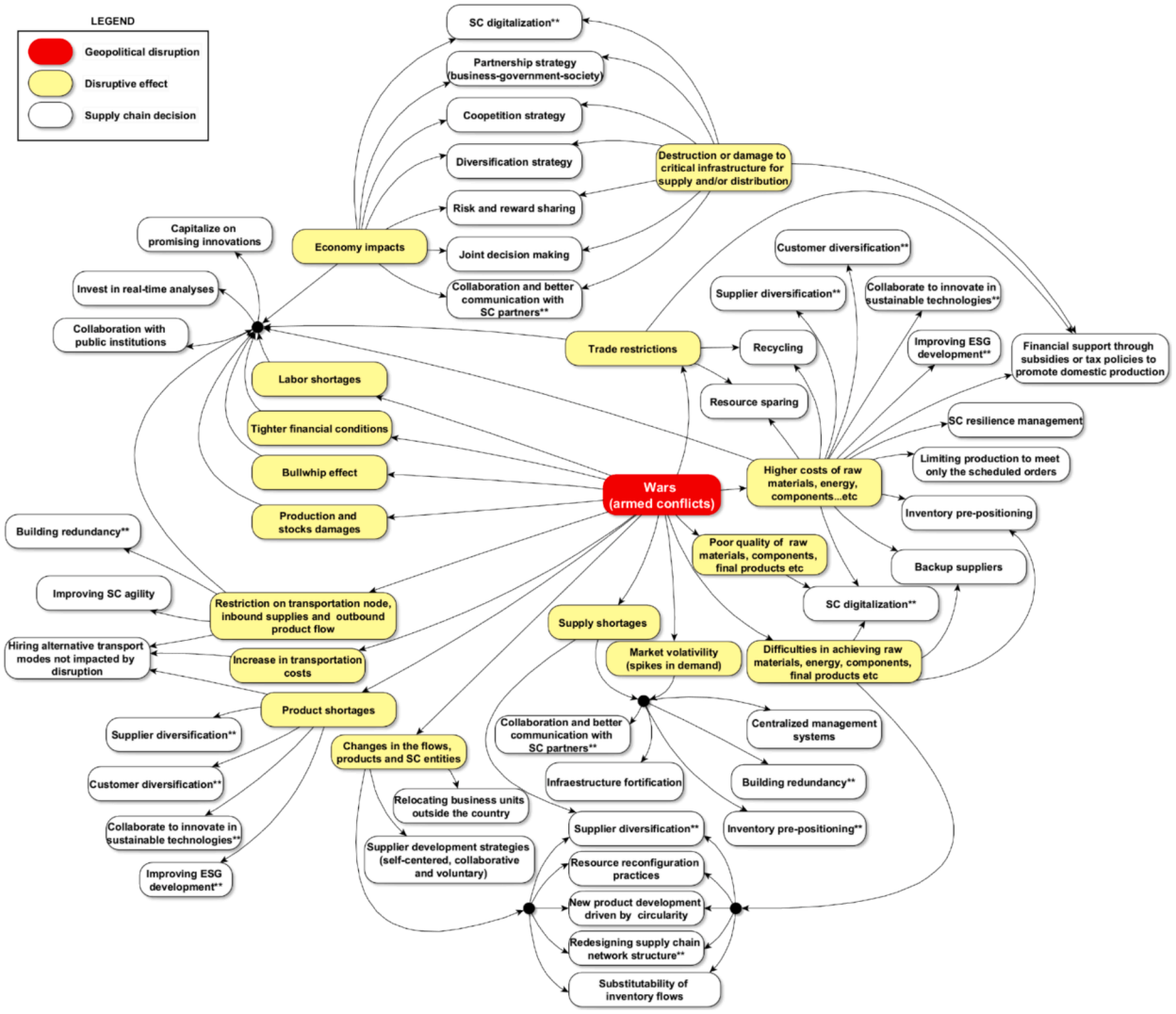

Fig. 10. Model on supply chain management in case of *wars (armed conflicts)*.

10. Discussion and implications

10.1. Theoretical implications

Especially in the last year or so, increasing geopolitical disruptions have shown themselves to be very able to threaten the activities of supply chains (Gambrell, 2023; Murray, 2023; Simchi-Levi and Haren, 2022; Stackpole, 2022). The findings of this research highlight that despite a growing body of research on geopolitical disruptions in supply chains published in the literature, only Bednarski et al. (2023) summarize the progress made in terms of technology use, design, configuration, and flow of disrupted supply chains. Our study also carried out an SLR that complements that recent SLR by focusing on the managerial supply chain decisions made to respond, mitigate, and/or recover from the effects of multiple geopolitical disruptions. Indeed, Bednarski et al. (2023) call for reviewing lessons learned, actions, and decision-making processes adopted in the past facing geopolitical disruptions. With this in mind, the results of the present study contribute to the literature in multiple ways.

Firstly, the results of this study contribute to identifying six types of geopolitical disruptions in supply chains, which extends the findings of recent works on the existence of multiple geopolitical disruptions (Bednarski et al., 2023; Caldara and Iacoviello, 2022; Hu et al., 2023). Specifically, Bednarski et al. (2023) review several literature surveys on supply chain disruption, noting that none of them deal specifically with geopolitical disruption and that common characteristics, effects, and solutions for geopolitical disruption in supply chains remain a gap in research. Meanwhile, Caldara and Iacoviello (2022) categorize geopolitical disruption into war threats, peace threats, military buildup, nuclear threats, terrorist threats, beginning of war, escalation of war, and terrorist acts. Their work focused on developing a metric to measure geopolitical risk from a macroeconomic point of view, not focused on individual companies

or supply chains. Lastly, Hu et al. (2023) differentiate between sovereign risk, military risk, and major power intervention, while further subcategorizing these into more specific categories leading to indicators. Their work was focused on countries along the Belt and Road and measuring how the countries' risk changes over time.

However, some redundancy between previous geopolitical disruptions identified in the literature can be appreciated. In order to avoid any overlap, the types of geopolitical disruptions were carefully delimitated and defined in the present research (See Table 4). Thus, future studies will be able to check the list of geopolitical disruptions defined in this study to appropriately identify the geopolitical disruptions they are investigating. According to the findings obtained in this research, this issue is critical because each geopolitical disruption leads to highly divergent impacts on supply chain operations.

Secondly, this article reveals the disruptive effects generated by each geopolitical disruption. It specifically contributes by providing a list of disruptive effects identified in the SLR for each geopolitical disruption (see appendix 1). Furthermore, the findings indicate if the disruptive effects altered material, financial, and/or knowledge flows, together with upstream and downstream of supply chains (see the supplementary material). The analysis of results also contributes to the literature, revealing that geopolitical disruption on one supply chain agent usually propagates the ripple effect across other supply chain agents.

Thirdly, the article summarizes the potential managerial supply chain decisions identified in the SLR for managing each geopolitical disruption (see appendix 2). These decisions were grouped according to strategies applied in supply chains to respond to, mitigate, or recover from geopolitical disruptions. Our findings indicate that strategies such as supply chain risk management (Chukwuka et al., 2023; Elzarka, 2013; Kauppi et al., 2016), security management (Russell and Saldanha, 2003; Voss and Williams, 2013), resilient supply chain management (Liu et al., 2023; Rahbari et al., 2023; Urciuoli et al., 2014), and viable supply chain management (Cimprich et al., 2019) are not the only effective approaches in the context of geopolitical disruptions. Managerial decisions implemented under other strategies, such as supply chain collaboration, digitalization, financial management, innovation management, location management, circular economy, and sustainable supply chain management, have also proven effective. Thus, our article extends the existing literature by formulating a comprehensive portfolio of robust strategies and decision-making mechanisms that can be implemented for managing geopolitical disruptions in supply chains. The deep analytical analysis of these results reveals novel insights scarcely addressed in prior research.

On the one hand, there exist synergies among supply chain strategies. Previous articles explore the integration of decisions/mechanisms derived from a resilience supply chain strategy with those derived from risk management (Blessley and Mudambi, 2022), supply chain collaboration (Provost et al., 2022), digitalization (Li et al., 2022), financial management (Davarzani et al., 2015), innovation management (Tse et al., 2024), location management (Charpin and Cousineau, 2024), circular economy, and sustainable supply chain management (Althaf and Babbitt, 2021). Through the theoretical lens of the Resource-Based View and DCT, Tsang et al. (2024) found that the adoption of policies aimed at improving Environmental, Social, and Governance (ESG) performance also

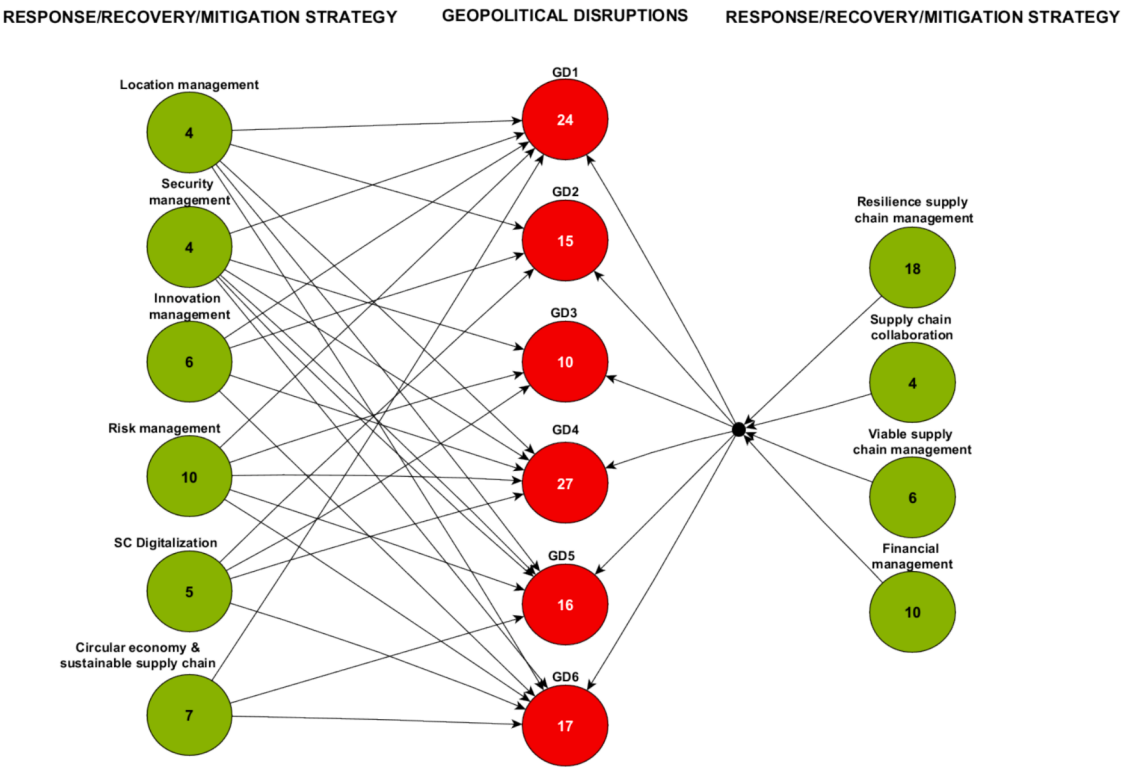

Fig. 11. Framework for managing geopolitical disruptions through executing response, recovery and mitigation strategies.

strengthens supply chain resilience during the Ukraine- Russia war.

On the other hand, our results highlight divergences among some managerial decisions/mechanisms. Enhancing Corporate Social Responsibility (CSR) performance and innovation capabilities helps mitigate the negative impacts of trade wars on buyer–supplier transactional relationships (Fan et al., 2024). This decision would undermine redundancy mechanisms, which are critical for resilience against trade war disruptions (Blessley and Mudambi, 2022).

Fourthly, the article provides six models specifically tailored for each one. Deep insights can be obtained from the analysis of the effects of disruption shown in the six models, leading to a better understanding of mitigation, response and recovery strategies that can be employed to deal with geopolitical disruptions in a comprehensive manner. It is easy to see that the effects of these disruptions are very widespread, and for this reason, one would expect a portfolio of strategies to be needed to conclusively address them. Thus, this study contributes to filling a gap in the literature, as no similar models have been developed to date.

Fifthly, previous theoretical frameworks have examined the management of geopolitical supply chain disruptions through various theoretical lenses. Both TCE and RDT have been applied to explore the effects of geopolitical tensions between countries on supply base complexity (Charpin and Cousineau, 2024). Those theories have also examined the effects of trade wars on transactional relationships between suppliers and their buyers (Fan et al., 2024). Charpin and Cousineau (2024) explored the effects of geopolitical tensions between countries on supply base complexity through the lenses of RDT and TCE. Drawing upon the Systemic Risk Theory and the DCT, Farrukh and Sajjad (2024) propose supply chain resilience enablers to mitigate the effects derived from political instability. The influence of protectionist trends on managers of foreign subunits in a host country has been examined through the lens of IT (Charpin et al., 2021).

Despite the growing body of research on geopolitical supply chain disruptions, literature lacked a unified framework that links types of disruptions with their effects and strategic responses. Hence, our article also contributes to the literature proposing the overarching framework presented in Fig. 11. This links the required strategies for mitigation, response, and recovery (green circles) to the effects of each geopolitical disruption (red circles). The number inside represents how many decisions/mechanisms (green circles) and disruptive effects (red circles) have been identified in the SLR (appendix 1 and 2). The proposed framework reveals that resilience supply chain management, supply chain collaboration, financial management and viable supply chain management can be applied to effectively manage any geopolitical supply chain disruption. Conversely, the other strategies cannot mitigate all types of geopolitical supply chain disruptions. Further advancements are required to gain a better understanding of this matter.

10.2. Future research directions

The analysis of the results obtained in this research reveals that further advances are needed in managing geopolitical supply chain disruptions. Accordingly, the main future research directions are outlined below.

- **Research direction 1: Evaluating the ripple effects caused by geopolitical disruptions in terms of supply chain structure, performance, and other parameters.**

The literature has already confirmed the occurrence of the ripple effect in other supply chain disruptions, such as pandemics (Ivanov and Dolgui, 2021; Queiroz et al., 2020) or natural disasters (Matsuo, 2015; Park et al., 2013), among others. Our study highlights that geopolitical disruptions also lead to these effects. However, it was not identified specific articles analyzing the ripple effects due to geopolitical disruptions.

- **Research direction 2: Conducting an SLR to develop a theoretical framework that synthesizes synergies among supply chain strategies in geopolitical disruption contexts.**

Despite previous studies revealed synergies between some supply chain strategies facing geopolitical disruptions (Althaf and Babbitt, 2021; Provost et al., 2022; Tsang et al., 2024), no theoretical framework has yet been developed to explore these interconnections in an integrated manner.

- **Research direction 3: Undertaking empirical studies to verify the existing synergies and divergences between supply chain strategies across multiple sectors and geographic locations.**

The analysis of the results highlights the potential existence of synergies and divergences among some managerial decisions/mechanisms and their corresponding supply chain strategies. However, our study revealed that no empirical studies have investigated the divergences, and only a few have explored the synergies between supply chain strategies.

- **Research direction 4: Developing optimization models and simulations to determine what supply chain strategies and mechanisms must be implemented to overcome geopolitical disruption scenarios.**

Given the high number of supply chain strategies and associated decisions/mechanisms identified in the SLR, there is a need to develop optimization models to determine which strategies and mechanisms must be adopted to address concrete geopolitical disruption scenarios, considering multiple objectives and constraints.

- **Research direction 5: Examining empirically how digitalization strategies differ in effectiveness across sectors, supply chain levels and regions facing different geopolitical disruptions.**

The six models (Figs. 5-10) synthesize decisions and mechanisms across a great variety of sectors. Nevertheless, these are not equally effective in all contexts. Focusing our attention on the digitalization strategy, Li et al. (2022) propose the implementation of Automated Identification System (AIS) data mining and machine learning to production declines in the oil transportation industry amid trade wars. However, this decision would not be equally effective in all contexts and industries. Moreover, previous studies explored how digitalization improves supply chain capabilities against geopolitical disruptions (Belhadi et al., 2024a; Kumar et al., 2023). In this way, no studies have been identified that consider supply chain levels as control or explanatory variables.

- **Research direction 6: Generating a strategic roadmap that guides firms to successfully advance towards an optimal digital maturity level in the supply chain to overcome geopolitical disruptions.**

The literature still needs to be extended to achieve proper supply chain digitalization for effectively managing geopolitical disruptions. With this in mind, it is key to generate a strategic roadmap that outlines companies the path toward more advanced levels of technological maturity.

- **Research direction 7: Developing instruments to measure the digital readiness and maturity of supply chains in facing geopolitical disruptions.**

The literature lacks specific instruments to help companies assess their digital readiness and the maturity of their supply chains to manage geopolitical disruptions.

- **Research direction 8: Developing methods for determining the portfolio of technological applications required for managing geopolitical disruptions, considering multiple criteria.**

Once companies become aware of digital readiness and the maturity of their supply chains, they should determine the portfolio of technological applications that need to be implemented. These complex decisions require considering multiple criteria that exceed human cognitive capacity to resolve. Despite their importance, this matter has been overlooked in previous studies.

- **Research direction 9: Exploring how digital transformation impacts dependencies between focal firms and their supply chain partners, as stated by RDT, especially with the rise of data as a critical resource for managing geopolitical disruptions.**

Drawing upon the RDT, companies may establish closer ties with key suppliers and logistic operators to collaboratively implement digital instruments based on a high volume of critical data. Future studies should explore how this digital transformation impacts dependencies between focal firms and their supply chain partners located across the globe amid geopolitical crisis.

- **Research direction 10: Developing an advanced theoretical framework that links geopolitical disruptions and strategic responses with operational, sustainable, and resilient supply chain performance measures.**

Given that the proposed framework (Fig. 11) integrates the disruptive effects and related decisions previously validated under well-established theories (e.g., RDT, TCE, DCT or IT), the results provide a solid foundation for the development of several future research avenues. Looking at Fig. 11, this does not include operational, sustainable, and resilient supply chain performance measures. This extension of the framework would allow for a more precise assessment of the effects of supply chain strategies.

- **Research direction 11: Developing novel methods to determine which portfolio of strategies, decisions, and mechanisms should be adopted to minimize geopolitical disruptions in a more efficient, sustainable, and resilient manner.**

To date, no methods have been found in the literature to support managers in the selection of strategies, decisions, and mechanisms to manage geopolitical supply chain disruptions. These would consider specific performance measures focused on efficiency, sustainability, and/or resilience.

- **Research direction 12: Exploring, through the lens of CAST, how the interactions between supply chain partners reinforce supply chain viability facing geopolitical disruptions at the systemic level.**

The results revealed that many articles examined the management of geopolitical supply chain disruptions under the lens of CAST (Cordell et al., 2015; Geng et al., 2017; Gong et al., 2020; Kovács and Falagara Sigala, 2021; Ren et al., 2024; Tan et al., 2024). Certain assumptions of this theory still require further empirical validation to address unresolved questions. For example, if the interactions between supply chain partners make possible the automated redesign of networks in the face of geopolitical disruptions at the systemic level.

- **Research direction 13: Extending the RDT by verifying how the adoption of location strategies, the formation of alliances or mergers, and the reconfiguration of supply chain structures can enhance resilience capabilities during geopolitical crises.**

Drawing upon the RDT, some articles have made significant progress on overcoming geopolitical supply chain disruptions(Charpin and Cousineau, 2024; Duong et al., 2024; Fan et al., 2024; Tan et al., 2024). The literature has not yet resolved how the adoption of location strategies, the formation of alliances or mergers, and the reconfiguration of supply chain structures can enhance resilience capabilities during geopolitical crises.

- **Research direction 14: Exploring if the degree of supply chain digitalization can act as a potential moderator or mediator between supply chain strategies and resilience capabilities in times of geopolitical disruptions, under the lens of the DCT.**

While the DCT is widely applied in the literature (Blessley and Mudambi, 2022; Farrukh and Sajjad, 2024; Roy et al., 2024; Tsang et al., 2024; Tukamuhabwa et al., 2017), the degree of supply chain digitalization remains insufficiently explored. It would act as potential moderator or mediator between supply chain strategies and resilience capabilities in the context of geopolitical disruptions.

- **Research direction 15: Examining how transaction costs affect decisions regarding outsourcing, offshoring, and reshoring in complex global supply networks, especially in the context of piracy or terrorism.**

TCE is the most widely applied theory in studies on geopolitical disruptions in supply chains. Previous research explored the transactional costs between buyers and suppliers located in areas affected by trade wars (Fan et al., 2024). However, Fig. 11 shows that location management has not yet been applied to examine the effects of terrorism and piracy within TCE perspective.

- **Research direction 16: Evaluating how institutional pressure moderates the effects of circular, sustainable, and innovation strategies on the agility of international supply chains facing geopolitical disruptions.**

As shown in Fig. 11, the adoption of innovation management, circular economy, and sustainable supply chain strategies does not appear to support effective response, recovery, and/or mitigation for certain geopolitical disruptions. From the perspective of IT (Cordell et al., 2015; Krykavskyy et al., 2023), it may be worth exploring whether institutional pressure plays a key role in encouraging the adoption of these strategies not only to enhance supply chain circularity and sustainability, but also to strengthen supply chain agility in the face of disruptions.

10.3. Managerial and policymakers implications

This study presents some practical managerial implications, as well as some implications for governments, public administrations, and policymakers. This research identifies the six main types of disruptions studied by supply chain management academic literature due to geopolitical reasons, and six models are accordingly proposed to map their effects and the managerial supply chain decisions adopted to respond, mitigate, or recover from these effects. These models could be used as a reference or a guideline for managers and policymakers to identify and better understand (i) the potential disruption effects that their companies might face when managing or being part of a supply chain and (ii) the action that they can undertake to respond, mitigate or recover from them. It could help them in their decision-making process to build or redesign their supply chains and make them more resilient and robust, i.e., developing capabilities to face crises or disruptions by being prepared ahead, maintaining operations, and recovering as fast as possible afterward.

For GD1 internal political stability, effects in the delay or disruption of material flows can occur from the lack of material itself or a disturbance in production machine tools or workers. On the other hand, transactions can be disrupted by changing demand patterns, incorrect documentation, the bullwhip effect, planning difficulties, and transaction-level uncertainty. In order to mitigate these effects, a multipronged response would need to include enhanced collaboration and coordination with both supply chain partners as well as public institutions, comprehensive supply chain management including supplier diversification, improving supply chain agility, and the use of insurance contracts to hedge political risk.

For GD2 political tension between countries, the effects contain actual or threatened disruption in material flow, loss of customers and orders, and trade disruption. The portfolio of strategies here would include the use of strategic stock and supply chain digitization alongside collaboration with public institutions and relocation of business units.

In GD3, piracy and terrorism result in actual or threatened production and transportation delays often resulting in income loss and economic impact. Here, the mix of strategies would include the use of strategic stock, supplier diversification, and extensive supply chain risk management alongside enhanced collaboration with public institutions.

For GD4 trade wars, the disruption of supply chain relationships manifests itself in a variety of ways from decreases in production and increases in transaction level uncertainty, to difficulties in both moving money and material. Mitigating these collectively requires a combination of supply chain network redesign including diversifying business outside the country and identifying alternative transportation modes alongside increasing collaboration with public institutions and protecting intellectual property.

In GD5 nationalist movements, effects can be felt on the demand side with changing consumer demands as well as on the supply side with supplier shortages and increased lead times. Delays and higher costs plague the supply chain as it reacts to the new legal and trade environment. Here, the strategies would include strategic stock and enhanced collaboration with supply chain partners alongside

supply chain redesign, including supplier diversification.

For GD6 armed conflicts, the effects include the destruction of material and inventory as well as production and transportation assets and capacity. Restrictions on trade will also impact the economy on the macro level as it impacts transactions and flows at the micro level. The portfolio of strategies here would include increased collaboration with public institutions, consideration of reshoring production, investing in real-time analysis and supply chain digitization, and increasing cash reserves.

The different business management recommendations mentioned above should be suitably adapted in an industry-specific manner. Thus, for example, in the automotive industry, where software and digital solutions to be incorporated into vehicles are becoming increasingly more important than the parts or components themselves, new agreements with domestic suppliers beyond the traditional overseas trade blocks should be promoted for both critical materials and technologies. Likewise, the selective stockpiling of critical components in advance, together with the implementation of effective inventory management systems, will be essential to reduce the effects of a disruption in the supply chain.

Regarding some other industries, such as, namely material industry, efforts should be concentrated on developing greener business models (by, for instance, increasing recycling rates, reducing energy use or introducing new production technologies), together with an investment in new technologies that enable an early detection, identification and monitoring of potential failures along the supply chain emanated from the diverse geopolitical risks consider in this study.

When considering the agrifood industry or any other similar industry with such a complex and long supply chain dealing with highly perishable products, the implementation of digital transformation initiatives, ranging from IoT scalable solutions to AI technologies that will allow to improvement of the monitoring and controlling capabilities across all the supply chain. It would also be advisable to search for and utilize raw materials substitutes, which would imply not only a resource reconfiguration but also the building of new relationships different from the existing ones with conventional raw material suppliers.

It must be said, however, that these mitigation strategies are not costless panaceas, and so a discussion of the costs, tradeoffs, and limitations presented by the strategies should be afforded. Strategic stock results in holding or carrying costs, an amalgamation of physical storage costs, obsolescence, and opportunity cost of capital. It should also be mentioned that the decisions on the location, timing, and amount of strategic stock are far from trivial. The redesign of the supply chain network and relocation of facilities adjusts strategic decisions with large costs and time horizons, something done with exceeding care and caution. One would expect during the redesign to have some new investments in fixed costs to add facilities and capacities, while having some unrecoverable sunk costs in places where we are curtailing operations. Comprehensive supply chain risk management takes effort and generates costs that will hopefully be offset by a decrease in the likelihood and magnitude of disruptions. Alternative transportation modes would be presumed to be more expensive than those in place before the disruption, and these costs would be hopefully offset by the flexibility they provide with the supply chain. Diversifying the supplier base can also be expected to increase the costs of the material we are purchasing, and may increase the inbound transportation costs, but redundancy in the supplier base may allow us to avoid some or all of the costs of a disruption. Collaborating with supply chain partners requires time and effort, and costs are thereby incurred, but there are very often benefits to the supply chain in terms of better decisions and reaction to disruption. Fostering collaboration with public institutions likewise will require time and effort measured in costs, the benefits of which might allow us to better deal with the disruption. Protecting intellectual property and hedging against political risk with insurance will have costs associated, as does investing in real-time analysis, agility, and digitalization. It should also be noted that digitalization of the supply chain has its limits as the technology emerges. All of this should be kept in mind both as a portfolio of strategies is crafted to mitigate risk proactively as well as reactively as the supply chain responds to a geopolitical disruption.

This research also presents some implications for governments, public administrations, and policymakers, as some of the above-proposed strategies deal with fostering collaboration initiatives between them and the concerned companies. Indeed, when applying some of the mitigation strategies mentioned in this study, policy makers, public administrations and governments also play an important role. Thus, for example, from a strategic point of view, our results reveal that these actors should: i. Promote and develop plans for joint collaboration with companies, ii. Promote the implementation of predictive analytics tools and artificial intelligence to anticipate geopolitical changes, as well as digital twins for the simulation of complex scenarios, iii. Support flexibility in location decisions, iv. Establish strategic partnership alliances that achieve the joint participation of companies, governments, and society.

Not only at a strategic level, public institutions and governments can also contribute more directly, especially through the economic and financial support they can give to companies, either through regulations and tax incentives that encourage local production, expansion to other international markets, or by applying a system of exception tariffs. These decisions could be crucial in the current context of protectionism and trade wars among multiple countries, characterized by increased trade restrictions, reshoring initiatives, and more restrictive international regulations.

11. Conclusions and limitations

As we have seen, today's geographically dispersed supply chains are very efficient at fulfilling the demand for goods and services, sourcing materials and adding value around the globe while moving products to the sphere of the consumer. But we have also seen spectacularly in the past years that these global supply chains are prone to disruption from viruses, wars, canals, and bridges, and further, these disruptions can take time to resolve, causing much economic damage to supply chains. Not all disruptions are the same, and disruptions due to geopolitical reasons like the Russia-Ukraine war, the Hamas attack and resulting Israel war in Gaza, and now the attacks on merchant ships transiting the Red Sea underscore the importance of examining in detail supply chain disruption resulting from geopolitical reasons and seeking to better understand effects and mitigation mechanisms. This work seeks to contribute by conducting an SLR on supply chain disruptions due to geopolitical reasons, highlighting the effects of the disruption and delineating

managerial decisions that can be made to respond, mitigate, and recover from these effects, as well as providing further future research directions.

The findings of this SLR allowed us to classify the types of geopolitical disruptions affecting supply chain operations into six groups, some of which are a result of tensions between countries, while others are a result of internal tension. Each of these six groups was then examined in greater detail to isolate specific effects of the disruption and to provide managerial supply chain decisions to respond, mitigate, and recover from them. Considering the relationships identified in the literature, we built a specific model for each type of geopolitical disruption. Its analysis provides some valuable contributions to academia while allowing future research avenues to be proposed. Moreover, this research presents some managerial implications, as the models can be used by managers and practitioners in industry to deliberate how disruptions can be dealt with. The classification of the different types of supply chain disruptions due to geopolitical causes, their effects, and the response, mitigation, and recovery actions could serve as a guideline or reference for industry practitioners. Even policymakers can gain a better understanding of how they can support managers and practitioners in managing supply chain disruptions due to geopolitical reasons.

Although this research has been conducted following a thorough and structured approach, it presents some limitations. This research did not consider the relationships between effects or the relationships between managerial supply chain decisions. These could not be accurately identified in the SLR. Future research should consider these relationships to propose supply chain decisions in a more effective way. Based on the models built for each geopolitical disruption, this research provides concrete strategies to respond, mitigate, and recover from the effects identified in the SLR. These strategies bring together a set of managerial supply chain decisions that only consider the relationships with the disruptive effects. However, the SLR did not allow critical criteria (i.e., cost, time, etc.) to be considered to assess another alternative set of decisions. This will be left to future research to consider and address.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1. List of disruptive effects caused by each geopolitical disruption.

Disruptive effects	GD1	GD2	GD3	GD4	GD5	GD6
Bullwhip effect	*					*
Changes in the flows, products and SC entities		*		*	*	*
Changes in trade laws and regulations	*	*			*	
Customer order cancellation		*				
Cyberattacks					*	
Damaged cargo	*					
Damages in warehousing	*					
Decrease in corporate foreign direct investment		*		*		
Defaulting customers		*				
Delays in transportation and transshipment	*		*	*	*	
Decrease in customer orders			*			
Decrease in production			*	*		
Decrease in profitability				*		
Destruction or damage to critical infrastructure for supply and/or distribution		*				*
Difficulties in achieving raw materials, energy, components, final products etc	*	*	*		*	*
Difficulties in making payments				*		
Difficulties in plan and execute schedules	*					
Difficulties in recruiting skilled workers					*	
Economy impacts	*		*	*		*
Financial difficulties	*	*		*		
Firms will face higher needs to process information	*		*		*	
Higher costs of raw materials, energy, components…etc		*		*	*	*
Higher levels of inventories				*		
Inadequate security procedures	*					
Income loss	*		*	*	*	
Incorrect documentation	*					
Increased lead-time	*		*	*	*	
Increased level of waste				*		
Increase in transaction costs		*				
Increase in transportation costs				*		*

(continued on next page)

(*continued*)

Disruptive effects	GD1	GD2	GD3	GD4	GD5	GD6
Increase of CO2 emissions				*		
Labor shortages				*		*
Limited capability knowledge building between SC members				*		
Lower productivity				*		
Lower service level				*		
Market volativility (i.e., spikes in demand)				*		*
Logistics blockages						*
Lost of reputation for suppliers		*				
Performance of personnel	*					
Poor customer delivery performance		*				
Poor quality of raw materials, components, final products etc				*		*
Production shortages						*
Production and stocks damages						*
Restricted access to workplaces for suppliers and worker	*					
Restriction on transportation node, inbound supplies and outbound product flow	*	*		*	*	*
Risk of intellectual property leakage					*	
Shifting consumer demands	*			*	*	
Short product life cycles	*					
Shutdown of the processing plant	*					
Stoppage of operations in the facility	*					
Supply/Supplier shortages				*	*	*
Technological and material constraints				*	*	
Threatening the production and distribution of final products		*	*			
Tighter financial conditions						*
Trade impacts	*	*		*		
Trade restrictions						*
Uncertainty surrounding transactions	*		*	*	*	
Volatibility prices	*					
TOTAL	24	15	10	27	16	17

Appendix 2. . Strategies and managerial supply chain decisions facing geopolitical disruptions

Mitigation, response and/or recovery strategies	Managerial supply chain decisions	GD1	GD2	GD3	GD4	GD5	GD6
Supply chain collaboration	Better communication with customers			*			
	Partnership strategy (business-government-society)						*
	Collaboration and better communication with SC partners	*		*	*		*
	Collaboration with public institutions	*	*	*	*	*	*
	Coopetition strategy	*			*		*
	Building social capital and relational competences				*		
	Joint decision making						*
Financial management	Altering the bank				*		
	Assessing potential stock market damage				*		
	Investing in operational slack and R&D capabilities			*			
	Debit-based payment				*		
	Finalizing financial transactions before delivery				*		
	Insurance contracting on political risk and investment (PRI)	*					
	Financial support from public institutions (subsidies or tax policies to promote domestic production)		*				*
	Applying for tariff exceptions				*	*	
	Penalty clauses in supplier contracts				*		
Viable supply chain management	Redesigning supply chain network structure		*		*	*	*
	Substitutability of inventory flows	*					*
	Supply chain network structure with consolidated nodes			*			
Resilience supply chain management	Building redundancy (Capacity backup, backup suppliers, strategic stock, etc)	*	*	*	*	*	*
	Centralized management systems						*
	Contingency planning			*	*	*	
	Customer diversification						*
	Diversification strategy (nationalist partners, business outside of the US and China, etc)				*	*	*
	Employing intermediary companies to procure parts				*		
	Flexible short and long-term contracts			*			
	Flexible contract with minimum order quantity				*		
	Hiring alternative transport modes not impacted by disruption	*		*	*	*	*
	Improving flexibility in transportation, storage and distribution	*	*		*		

(*continued on next page*)

(*continued*)

Mitigation, response and/or recovery strategies	Managerial supply chain decisions	GD1	GD2	GD3	GD4	GD5	GD6
	Inventory pre-positioning				*		*
	Resource diversification	*	*	*			*
	Supplier diversification	*	*	*	*	*	*
	Improving SC agility	*			*		*
	Product and process standardization and modularization	*				*	
	Pulling purchase orders or production forward				*		
	SC resilience management	*					*
	Supplier development strategies (self-centered, collaborative and voluntary)		*		*		*
Risk management	Avoidance strategy				*		
	Creating a risk management culture				*		
	Applying a dynamic model to manage risk propagation			*	*		
	Extensive SC risk management	*		*	*		
	Preserving intellectual property				*		
	Limiting production to meet only the scheduled orders						*
	Limiting technology collaboration				*		
	Market allocation						*
	Risk planning			*			
	Vertical integration strategy	*		*	*	*	
Innovation management	Capitalize on promising innovations						*
	Collaborate to innovate in sustainable technologies						*
	Differentiation strategy				*		
	Improving innovation capabilities		*				
	Increasing innovations	*	*				
	New product development driven by technological innovations				*		
Security management	Control and management of the security of overseas business partners			*	*		
	Adoption of military concepts (agility, reservists, pre-positioning) in logistics management			*			
	Infrastructure fortification						*
	Fostering the establishment of a security-based organizational culture across the SC	*		*			*
Circular economy and sustainable supply chain management	Improvement of recycling technology				*		
	Improving CSR performance		*				
	Improving ESG (Environmental, Social, and Governance) development						*
	New product development driven by circularity						*
	Recycling		*				*
	Resource sparing	*					*
	Resource reconfiguration practices						*
Supply chain digitalization	Improving visibility with IT systems				*		
	Predicting and estimating product flows with big data			*	*		
	Supervising and analyzing product flows in real time with AIS data mining and machine learning			*	*		
	Invest in real-time analyses						*
	Supply chain digitalization		*				*
Location management	Friendshoring, nearshoring and/or reshoring		*		*	*	
	Relocating business units outside the country		*		*	*	*
	Strategic locations	*					
	Strengthening the local supply chain structure						*

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tre.2025.104290.

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