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## **Risk, Generative AI, Disinformation Control, Global Supply Chains, and Social Impacts**

### **Professor Pervaiz Akhtar**

The University of Aberdeen Business School, University of Aberdeen  
Aberdeen, United Kingdom  
[pervaiz.akhtar@abdn.ac.uk](mailto:pervaiz.akhtar@abdn.ac.uk)

### **Professor Thanos Papadopoulos**

Kent Business School, University of Kent, United Kingdom  
[a.papadopoulos@kent.ac.uk](mailto:a.papadopoulos@kent.ac.uk)

### **Dr Huda Khan**

Huda Khan  
The University of Aberdeen Business School, Africa-Asia Centre for Sustainability Research,  
University of Aberdeen, UK  
Innolab, University of Vaasa, Finland  
[huda.khan@abdn.ac.uk](mailto:huda.khan@abdn.ac.uk)

### **Dr Arsalan Mujhaid Ghouri**

London South Bank University, United Kingdom  
[ghouria3@lsbu.ac.uk](mailto:ghouria3@lsbu.ac.uk)

### **Dr Saqib Shamim**

School of Business and Management,  
Queen Mary University of London, UK  
Innolab, University of Vaasa, Finland  
[s.shamim@qmul.ac.uk](mailto:s.shamim@qmul.ac.uk)

### **Dr Aniqashraf**

CAS-Key Laboratory of Crust-Mantle Materials and the Environments, School of Earth and Space  
Sciences, University of Science and Technology of China, 230026, Hefei, PR China  
[aniqa@mail.ustc.edu.cn](mailto:aniqa@mail.ustc.edu.cn)

## **Bio:**

**Professor Dr. Pervaiz Akhtar** is Chair (Full Professor) in Business Analytics, Big Data, and Supply Chains at the University of Aberdeen, United Kingdom. He also served as Director of MBA Programmes from 2020 to 2024. Before joining Aberdeen, he was Associate Dean of Graduate Studies. His accomplishments have set records; he became the youngest professor from his country of origin to receive three consecutive promotions at the same university—a historic achievement within that institution. This also placed him among just over 150 academics across all disciplines in the UK who attained professorship before the age of 35, according to HESA records.

Professor Akhtar is a firm proponent of lifelong learning. A graduate of Imperial College London, and with over 20 years of combined experience in academia, consultancy, and industry—spanning public, private, and non-profit sectors—he has published in top-tier international journals such as the *International Journal of Operations & Production Management*, *Journal of Product Innovation Management*, *British Journal of Management*, *International Journal of Production Economics*, *Business Ethics*, *Technological Forecasting and Social Change*, *IEEE Transactions on Engineering Management*, *Journal of Business Research*, *Process Safety and Environmental Protection*, among others. Professor Akhtar served as Senior Associate Editor for the *International Journal of Physical Distribution & Logistics Management* and is currently a member of the editorial boards of the *British Journal of Management* and the *Journal of Knowledge Management*.

**Professor Thanos Papadopoulos** is Deputy Dean at KBS and a member of the Centre for Logistics and Sustainability Analytics (CeLSA). He was formerly the Head of the Department of Analytics, Operations & Systems. Prof. Thanos joined KBS in 2016. He obtained his PhD from Warwick Business School, University of Warwick, UK, his MSc in Information Systems from the Department of Informatics of the Athens University of Economics and Business, Greece, and his Diploma (Dipl-Eng, equivalent to MEng) in Computer Engineering and Informatics from the School of Engineering of Patras University, Greece. Prof. Thanos has published over 150 articles in peer reviewed journals and conferences including the *British Journal of Management*, *Decision Sciences*, *European Journal of Operational Research*, *International Journal of Operations and Production Management*, *International Journal of Production Research*, *IEEE Transactions on Engineering Management*, *International Journal of Production Economics*, *Technological Forecasting and Social Change*, and *Production Planning and Control*. Thanos is an Associate Editor for the *British Journal of Management*, *International Journal of Operations and Production Management*, and *Decision Sciences*.

**Dr Huda Khan** is Senior Lecturer in Marketing & an Associate Director of Africa-Asia Centre of Sustainability Research. Huda is also a Visiting Researcher at the InnoLab, University of Vaasa, Finland. Her work has appeared in many leading journals including *British Journal of Management*, *Journal of Product Innovation and Management*, *Industrial Marketing Management*, *Technovation*, *Technological Forecasting and Social Change*, *Management International Review*, *International Business Review*, *IEEE Transactions on Engineering Management* among others. She is an Associate Editor at the Rutgers Business Review and affiliated with the editorial review boards of *the Journal of Business Research*, *International Marketing Review*, *Journal of Knowledge Management*, *Multinational Business Review* and *Critical Perspectives on International Business*.

**Dr Arsalan Mujhaid Ghouri** is an educationist and researcher at London South Bank University, UK. He has published in leading journals e.g. *Journal of Business Research*, *Journal of Business*

*Ethics, Technological Forecasting and Social Change, Annals of Operations Research and IEEE Transactions on Engineering Management.* He has secured 15 international and local research grants.

**Dr Saqib Shamim** is a Senior Lecturer (Associate Professor) in Social Innovation and Strategy and Programme Director for the Innovation and Entrepreneurship MSc at the School of Business and Management, Queen Mary University of London. Previously, he served as Lecturer in Innovation and Entrepreneurship and Director of the International Business BSc at Kent Business School, University of Kent. His research interests include innovation management, digital transformations, dynamic capabilities and strategic alignment. He has published in journals such as the *British Journal of Management, Information and Management; International Business Review; International Journal of Human Resource Management, International Journal of Hospitality Management, Technology Forecasting and Social Change, and Computers in Human Behaviour, among others.*

**Dr Aniqashraf** is affiliated with the University of Science and Technology of China. She is a Senior Researcher and Expert in Environmental Science and Engineering: treating water and organic/antibiotic pollutants and tackling environmental, sustainability, and circular economy challenges to meet net-zero goals. With experiences from industry and academia, her research has appeared in high-impact journals such as *Science of the Total Environment, the Journal of Cleaner Production, Environmental Science and Pollution Research, IEEE Transactions on Engineering Management, and Annals of Operations Research, among others.*

## **Risk, Generative AI, Disinformation Control, Global Supply Chains, and Social Impacts**

### **Abstract**

The use of generative artificial intelligence (GenAI) is increasing the control risks in business operations. Disinformation control and geopolitical risk management are emerging concerns for supply chains. In the presence of these developments, this study addresses a gap in literature by applying balance-of-power theory (BPT), and it employs partial least squares structural equation modeling (PLS-SEM) to test the framework and relationships. Data were collected through a survey of 209 managers in China's maritime logistics sector. The sample covers shipping, freight services, port operations and maritime support services in Shanghai, Ningbo and Qingdao. The results show that GRR is the main driver of GSCR. GenAI use partly explains how GRR translates into stronger GSCR. The findings also show that the role of GRR depends on unity and balance of power. These factors support global supply chain resilience and help control quality, time and cost in operations. Disinformation control has a positive moderating effect and further strengthens GSCR in maritime activities. The study contributes to research on BPT, GRR and the growing use of GenAI in supply chains. It also offers theoretical, practical and policy insights and outlines directions for future research.

### *Keywords:*

Geopolitical risk reduction

Generative AI

Disinformation Control

Global Supply Chain Resilience

## 1. Introduction

Geopolitical conflicts are disrupting industries and transportation routes (Forbes, 2024). The transit time in the Red Sea has increased by roughly 30%. Additionally, the shipping costs are also rising and container capacity decreasing. 9% (Morgan, 2024). These factors affect global supply chains and offer the opportunity to enhance global supply chain resilience (GSCR) (Morgan, 2024). Flow of goods is affected by intentional and unintentional disruption in transportation routes, which poses a challenge for the executives and policy makers. Any kind of disruption slows global supply chains and logistics. Therefore, interconnected societies are feeling the impact of these blockades. Numerous nations in Europe, North America, and Asia are witnessing significant disruptions in their transportation routes. Shipping disruptions cause basic goods shortages, underscoring the need for more flexible and resilient supply chain systems. According to Roscoe et al., (2020) and Bednarski et al., (2024) geopolitical disruptions increase supply chain vulnerability and reduce resilience. The mechanisms that reduce firm risks, such as supply chain vulnerability and low resilience, remain underexplored.

Understanding how these mechanisms help firms achieve resilience is still limited in current research. Accordingly, practitioners and scholars have started to take an interest in understanding how such risks are linked to disruptions in different parts of supply chains (Bednarski et al., 2024; Forbes, 2024; Moradlou et al., 2021; Roscoe et al., 2022; Roscoe et al., 2020). Additionally, disinformation and fake news control using Generative artificial intelligence (GenAI) is not only crucial for GSCR (Akhtar et al., 2023; Chatterjee et al., 2023; Petratos and Faccia, 2023; Spanakiet al., 2023), but also for general society and other stakeholders (Ma et al., 2025). GenAI role is accelerating social change (Akhtar et al., 2024; Chowdhury et al., 2024), and disinformation control can further enhance the originality and its social impacts. Large Language models using GenAI play (e.g., Grok-3 for the X-formally called twitter) an emerging role to analyse and detect disinformation. They working as the counteracting against disruptions and negative social impacts (Mazza, 2025). GenAI's potential in risk prediction and decision support is recognised (Ivanov et al., 2021; Li et al., 2024). GenAI role in mediating geopolitical risk reduction and resilience with disinformation control has not been empirically tested. There is still much to understand and learn about how businesses can manage these risks well. Our research aims to help fill this gap.

Shipping and freight services, port operations, and maritime support services are among the industries most affected by geopolitical upheavals. These sectors are now working to develop ways to reduce geopolitical risks (GRR) (Ali et al., 2024; Kotcharin & Maneenop, 2020a, 2020b). However, there is still limited understanding of how these risk-reduction strategies influence GSCR during geopolitical crises that affect many societies. This gap is especially important for studying resilience in the Chinese maritime logistics sector, where Shanghai alone handled over 47 million TEUs in 2022 (The Maritime Executive, 2023; UNCTAD, 2023). In our research, we conceptualized GRR by means of two main attributes: 'unity' and 'power balance'. Unity refers to how firms collaborate strategically with industries and countries to the end of mitigating any negative disruptions caused by geopolitical tensions (Castañer and Oliveira, 2020; Devi et al., 2023). GRR can also be viewed as involving the preservation of a stable power balance within the system, which is essential to the existence of a stable international order (Wu, 2018). As such, it refers to the establishment of a stable and equitable industrial environment suited to enable risk reduction (Graham and Serdaru, 2020; Hong, 2020). Through the lens of balance of power theory (BPT), the strategic collaboration

between certain countries or regions and between the industries within those regions, and equitable power would enable to strike an equilibrium between the parties, which would make it possible to streamline fair propaganda and policies for enactment (Haas, 1953).

While the reduction of geo-political risk through unity and power balance can lead to supply chain resilience and established societies, the relationship may not be direct. GRR encourages firms to use GenAI due to its efficacy in forecasting demand, scheduling, sourcing strategy, distribution and transportation, inventory handling, process designs, strategy, and risk reduction in supply chains (Jackson et al., 2024). In order to address any logistical disruptions and supplier-specific risks linked to geopolitical instabilities, supply chain processes need to be more agile in terms of reducing risks. In this regard, supplier-industry collaboration (unity) should be expedited for proactive and effective risk-related responses (Deloitte, 2024). Similarly, power balance may enable the equitable solutions process or progress (Layne, 1998). Any imbalance has the potential to complicate the relationships between market players and leading to inequitable profit margins and disrupting sourcing of supply chain (Scherrer, 2022).

One approach to enhancing resilience under geopolitical crises is adopting GenAI. GenAI would respond to real-time risk assessment and artefact development in supply chain activities. Therefore, firms can direct their attention to value-adding activities which leads to supply chain resilience. The literature also consistently highlights how GSCR be achieved through the adoption of contemporary digital technologies such as GenAI and relative disinformation controls (Ivanov et al., 2021; Li et al., 2024; Akhtar et al., 2023).

GenAI algorithms can be used to proactively anticipate any potential threats by scanning disruptive events such as geopolitical crises and relative impacts on society. In doing so, they may also produce agile operational and strategic risk mitigation plans, run scenario simulations, and automatically generate risk assessment reports suited to aid the efficient management and mitigation of hazards (Deloitte, 2024; Wong et al., 2024). GenAI can greatly shorten the reaction times involved in risk mitigation processes and lead to contextualized and real time responses to risk events through system-guided, data-facilitated strategies built upon extensive libraries of scenarios and risk mitigation levers (Fosso Wamba et al., 2024), also can counter act against disinformation (Mazza, 2025). Guo, Jia, and Chen (2026) believe that GenAI can playing a transformational role by improving supply chain resilience and “there is an urgent need to explore its potential in enhancing business resilience and the influence on supply chain resilience remains empirically underexplored (p.1).” Particularly, the effects of GenAI on supply chain resilience and its links to disinformation control have mostly not been explored.

Our study makes two main contributions. First, it shows how GRR can help make supply chains more resilient. It also examines whether GenAI and other AI-based tools for disinformation control are actually effective. Practitioners, policymakers, and scholars are increasingly concerned with how supply chains can remain resilient during geopolitical crises, and this study offers empirical evidence on that question. It further clarifies the role of GenAI in supporting both supply chain sustainability and resilience. Second, the study contributes to BPT by focusing on crisis management in supply chains and logistics. It underscores the importance of a more balanced distribution of power and closer coordination between actors to reduce risk. Integrating these governance

mechanisms with GenAI and robust disinformation controls can strengthen overall supply chain resilience. Finally, our work speaks directly to the context of shipping and freight services, port operations, and maritime support services, which are particularly exposed to geopolitical tensions. Our empirical findings are therefore especially relevant for these strategically crucial industries. Our study's practical and policy contributions are also discussed for broader societal impacts.

## **2. Theoretical background and hypotheses**

### *2.1 Balance of power theory and its significance*

BPT, which is historically important (e.g., Haas 1953), plays a key role in international relationships and geopolitics. The main idea of BPT is to distribute power fairly so that no single group dominates. This helps prevent a few countries from gaining excessive control or resorting to intimidation. Geographical factors, such as location and resources, are also important for maintaining power balance. In fact, regional balances of power are interlinked with land and sea powers striving to dominate regions (Paul et al., 2010; Wu, 2018). Countries with growing economic and military power (e.g., China) are shifting the regional and global BPT dynamics. The balance of power concept is considered to be better suited to multipolar world in which power is distributed among many players, rather than just one or two countries (Wu, 2018). Balance power structures also include economic and technological factors; in particular, AI is reshaping the balance of power (Wight, 2023). Military power, natural resources, technological advancements, and economic development all play a crucial role in strengthening the application of BPT (Wight, 2023; Wu, 2018). Conflicts between powerful and weak countries could be very destructive, particularly for the weaker belligerents, the infrastructures of which could be destroyed, with all the expected consequences. This has been the case for many regions, from Kashmir to the Middle East, to Europe. This can affect geopolitical views and urge people to react against the unnecessary use of power against them. On the other hand, the chances of conflicts breaking out between equally powerful countries are low.

#### *2.1.1 Balance-of-Power Theory at the firm level with alternative lenses*

Balance-of-Power Theory (BPT) is a macro-international relations framework (Haas, 1953; Wu, 2018). It is suited to explain firm-level GRR in global supply chains. BPT directly links inter-state and inter-industry power dynamics to organizational survival strategies in contested environments. Unlike the dynamic capabilities that usually focus on internal adapting (i.e. sensing, seizing, and transforming) (Teece et al., 1997). BPT highlights external equilibrium-seeking behaviors while disruptions originate from sovereign/ nationalism actions (e.g., sanctions, blockades, trade wars). Resource orchestration assumes resource control (Sirmon et al., 2011). In shipping, firms do not "orchestrate" marine routes or port access controlled by countries or states. Institutional theory accounts for organizational compliance but falls short in explaining proactive coalition-building against geopolitical threats (DiMaggio & Powell, 1983).

Shipping and ports activities initiate the geopolitical risk as state or countries orchestrated disruptions (e.g., Houthi attacks, U.S.-China tariffs). Firms cannot unilaterally adapt i.e. dynamic capabilities or conform i.e. institutional theory. They must co-align with other actors to restore

systemic balance between entities. BPT's unity maps to cross-industry and cross-border coalitions (e.g., COSCO collaborating with European ports to bypass Red Sea). Power balance maps to negotiated access and equitable regulation. These are not internal capabilities but inter-organizational equilibrium strategies which falls into the BPT's domain.

GRR consists of two theoretically sufficient dimensions i.e. unity and power balance. According to the BPT equilibrium in international systems arises primarily from collaborative alliances (unity) to counter threats and from the equitable distribution of influence (power balance) to prevent dominance. Unity and power balance facilitate the reduction of firm-level risk in geopolitically contested shipping routes. They reflect the core mechanisms of the BPT as external coalition-building and systemic stability. The macro-level factors, e.g., military alliances are less relevant to firm operations in maritime logistics. Therefore, risks arise mainly from state-orchestrated blockades rather than internal firm capabilities.

This BPT rationale and logic align with our hypotheses (e.g., H1 tests GRR's direct effect on GSCR), measures (e.g., GRR as second-order construct of unity and power balance), and analysis (e.g., mediation in H4 and moderation in H5 capture firm-level equilibrium effects).

## *2.2 Hypotheses*

### *2.2.1 Geopolitical risk reduction and global supply chain resilience*

Geopolitical risks refer to uncertainties or potential threats that arises from the unseen scenarios and instabilities in specific geographical areas. Political instability, international conflicts, shifts in government policies, trade wars, sanctions, and other political events can disrupt global trade. In recent years we witness the trade tensions between global economies (e.g., the USA-China trade war), military disputes (e.g., the Russia-Ukraine conflict and the war between Israel and Palestine), political instability or regime changes, economic sanctions on countries or regions (e.g., sanctions on Iran) and regulatory shifts (e.g., Brexit, shifts in trade agreements) (Baur & Smales, 2020). When geopolitical risks are reduced, the likelihood of supply chain disruptions in global supply chain due to military conflicts or other reasons also decreases (Roscoe et al., 2020; Akhtar et al., 2016). Lower geopolitical tensions help create a more stable and predictable flow of goods. This encourages international collaboration and open trade between countries and their entities. It provides the chance to diversify the supply chains and become more flexible in operations (Charpin et al., 2024). In a reduced-risk environment different associated costs such as tariffs and shipping also decrease. Additionally regulatory compliance becomes more predictable and this makes supply chain management more efficient.

Lower geopolitical risk lets companies plan further into the future with more confidence and less doubt. It provides the opportunity to invest in operational improvements. That initiative minimises the likelihood and impact of disruptions (Roscoe et al., 2020). In other words, GRR is an important driver to enhance the GSCR. Resilience is a supply chain's ability to withstand external shocks and smoothen the operations and routines (Chatterjee et al., 2023). It restores the operations' normal or acceptable level within a reasonable time frame (Ponomarov & Holcomb, 2009).

Lower geopolitical risk tends to strengthen supply chains. First, it allows firms to diversify their supplier base across multiple countries. It allows firms to easily switch suppliers and divide the risk by avoiding overreliance on a single region (Müller, 2023). Second, companies operating in more stable environments can access critical resources more reliably. It enhances the support for GSCR performance (Cao et al., 2023).

Many industries depend on resources from unstable regions. Therefore, reducing tensions makes access to those resources safer (Müller, 2023). Third, stable geopolitics means fewer problems with transportation and logistics. Political conflicts can block shipping routes or impede border crossings. Stability in geopolitics reduces the risk of delays and helps goods and services movement from one place to another (Kotcharin & Maneenop, 2020a; Lai et al., 2020).

Finally, GRR creates more favourable investment environments for supply chain infrastructure. Firms are more likely to invest in research & development of technology and infrastructure in politically stable environments (Depren et al., 2024; Fania et al., 2020). It leads to stronger and more resilient supply chains capable of withstanding future disruptions. Based on these arguments, we expressed this first hypothesis.

***H1. Geopolitical risk reduction promotes global supply chain resilience.***

### *2.2.2. Geopolitical risk and generative artificial intelligence*

AI has the ability to interpret data, ultimately learn from it, and then use the gained knowledge to attain specific objectives and perform given tasks using adaptable methods. (Kaplan & Haenlein, 2019). However, the term AI lacks a specific definition, as it refers to a range of modern technologies such as robotics, neural networks, machine learning, computer vision, or virtual agents (Furman & Seamans, 2019). AI technologies have the ability to learn knowledge and to use it for automating and speeding up work that could previously only perform by humans. Contrasting with traditional computer programs, with their pre-programmed instructions, AI can learn, improve, and adapt according to new learning (Chalmers et al., 2021).

AI represents a new generation of technologies that has the capabilities for interacting with their environments by gathering information either externally or from internal systems (Glikson & Woolley, 2020). One of the most widely used elements of AI is machine learning, or GAI, which is frequently employed in tasks like modeling, prediction, and pattern recognition. Companies feel more confident and secure about the future in low geopolitical risk environments. This situation creates an opportunity for firms to invest in new technologies such as GenAI (Uddin et al., 2023). Lower-risk environments help global supply chains remain more stable (Roscoe et al., 2020), and firms are then more inclined to adopt digital tools to manage and improve their supply chain activities (Corrales & Westhoff, 2006; Hooks et al., 2022). In contrast, when geopolitical risk is high, supply chains are more likely to be disrupted, and firms tend to prioritise crisis management over the adoption of new technologies (Ponis & Ntalla, 2016).

Under lower levels of risk, companies can use AI to enhance forecasting, automate operational tasks, and support better decision-making in supply chain management. Stable political

conditions also give governments room to design long-term policies and regulations, which in turn encourage businesses to adopt new technologies such as GenAI (Moshi & Mwakatumbula, 2017). Existing research indicates that a favourable political climate positively shapes how technology and innovation interact (e.g. Wang et al., 2023). Governments are more likely to support research and development in digital technologies and other areas in the business sector in stable periods (Stephens et al., 2008). In contrast, protectionism and reduce cooperation between countries on technology issues raise due to the high geopolitical risks (Liou et al., 2023). When risks are low, countries are more willing to share data and technology Its upports joint research and speeds up technology development and adoption. Based on this reasoning, we propose that lower geopolitical risks and less regulatory uncertainty increase the likelihood that firms will adopt GenAI. Supportive legal frameworks encourage businesses to commit resources to new technologies.

Lower risks help create stable environments and encourage investment in technology. They also lead to better regulations and more international cooperation. These changes reduce the uncertainty that often slows innovation, making it easier for businesses to use AI. Based on this, we made the following point:

***H2. Geopolitical risk reduction encourages the use of GenAI Technology***

***2.2.3 Generative artificial intelligence and global supply chain resilience***

Supply chain engineering and management are important topics in the industry (Jackson et al., 2024). As GenAI growing and spreading in the industries and sectors, the companies need to quickly understand the new technological developments (Brynjolfsson et al., 2023; Stokel-Walker & Van Noorden, 2023). Understanding the emerging technology is more important then to focus on specific tasks and use of that technology. This approach is more practical and relevant for managing supply chains (Mithas et al., 2022).

AI and GenAI are designed to perform specific tasks or roles (Jackson et al., 2024). In perspective of supply chain management these technologies integration is more important where their functions and effects on operations matter (Kumar et al., 2018). AI and GenAI can make supply chains stronger by improving learning about the operations. These technologies can help to predict and adaption with the reasoning and the creativity (Jackson et al., 2024). GenAI also helps with real-time decision-making on live data in supply chains which increases resilience (Duan et al., 2019; McGovern et al., 2017; Belhadi et al., 2022). GenAI can handle large amounts of data and predict possible disruptions to make better decisions. This allows them to respond quickly to supply chain problems (Gupta et al., 2024). GenAI face fewer delays and recover faster from disruptions which ultliately help the companies. GenAI also supports strategies to diversify supply chains to boosts resilience (Yin & Ran, 2022).

AI models can create different scenarios and disruptions to understand the possible situation and decision making. It helps to improve sourcing strategies and diversify suppliers and production sites. Companies that use GenAI in their supply chains tend to be more resilient due to the vast pool of suppliers. It lowered the risk of depending on a single region or vendor (Wang & Pan, 2022). Research also shows that using smart digital technologies makes supply chains stronger (Akhtar et

al., 2022; Wang & Pan, 2022). GenAI positively impacts supply chain reliance in terms of improving operational efficiency (Guo et al., 2026). Based on these points, we developed the following hypothesis.

**H3.** *The use of generative artificial intelligence technology leads to global supply chain resilience*

#### *2.2.4. The mediating role of generative artificial intelligence*

GenAI offers automation in the operations and predictive modeling. These support data-driven decision-making and helps to generate more adaptable and resilient supply chains (Wang & Pan, 2022). Organizations are more likely to adopt digital technologies such as GenAI in their supply chains when geographical risks are lower to improve resilience (Uddin et al., 2023). Lower geopolitical risks also encourage firms to invest in key generative AI related technology segments (Stephens et al., 2008). It boosts adaptability and efficiency of the organization (Akhtar et al., 2022). Therefore, we argue that GenAI is an important tool for real-time decision-making and prediction in global supply chains. GSCR is strengthened when geopolitical risks are low. In such contexts, GenAI can support firms in improving demand forecasting and logistics decision-making, thereby enhancing overall resilience (Wang & Pan, 2022). Lower-risk environments also enable more flexible supply chain designs (Modgil et al., 2022). GenAI can then be used to develop predictive models of potential disruptions, allowing companies to switch suppliers and adjust logistics and production plans in response to early warning signals from these technologies (Wong et al., 2024). Together, these points suggest that GenAI is an important tool in lower geopolitical risks which lead to stronger GSCR. It improves real-time decisions with flexibility in operations and activities, and analytics. Based on these ideas and the literature, we argue that as geopolitical risks go down, GenAI can make supply chains even more resilient. Based on these points, we developed the following hypothesis.

**H4.** *The use of generative artificial intelligence technology mediates the relationship between geopolitical risk reduction and global supply chain resilience.*

#### *2.2.5. The moderating role of disinformation control*

Disinformation is the deliberate creation and spread of false information (Akhtar et al., 2023). In recent years, fake news, misinformation, and disinformation have significantly disrupted supply chains (Akhtar et al., 2023; Petratos & Faccia, 2023). The challenges posed by disinformation are intensified by the rise of social media and relative social change (Petratos & Faccia, 2023). Amongst the potential negative outcomes of fake news and disinformation on firms are several as: 1) loss of sponsorships 2) reduction of credibility and reputation. These aspects are negatively affect performance (Di Domenico & Visentin, 2020). Therefore, disinformation needs to be controlled.

Limited research has examined how disinformation control shapes the outcomes of AI-enabled insights in supply chains (Akhtar et al., 2023). Existing work suggests that technological proficiency can reduce the impact of disinformation on businesses (Chatterjee et al., 2023), and prior studies highlight the close link between AI and fake information (e.g., Akhtar et al., 2023). However, further

research is needed to understand how controlling disinformation can improve the quality of AI-driven insights. We also argue that disinformation management can shape the way GenAI influences GSCR.

GenAI can enhance supply chain transparency by providing accurate, real-time information (Duan et al., 2019; McGovern et al., 2017). Disinformation, however, may undermine this benefit by creating confusion and eroding trust in AI outputs (Shamim et al., 2023; Vaccari & Chadwick, 2020). Studies indicate that controlling disinformation can increase the credibility and perceived usefulness of new information technologies, supporting better decision-making and more resilient operations (Spanaki et al., 2023). GenAI can also improve demand forecasting by analysing large datasets and real-time information (e.g., Raza & Khosravi, 2015), but if disinformation distorts market signals or demand data, it can weaken AI-driven insights (Akhtar et al., 2023). Controlling disinformation helps ensure that the data fed into AI systems remains accurate, thereby strengthening GSCR. AI also supports risk management by processing large volumes of data on geopolitical, supplier, and market trends (Baryannis et al., 2019). Yet disinformation can distort this risk analysis by introducing misleading inputs. When disinformation is effectively controlled, AI can more accurately assess and mitigate risks, making global supply chains more resilient.

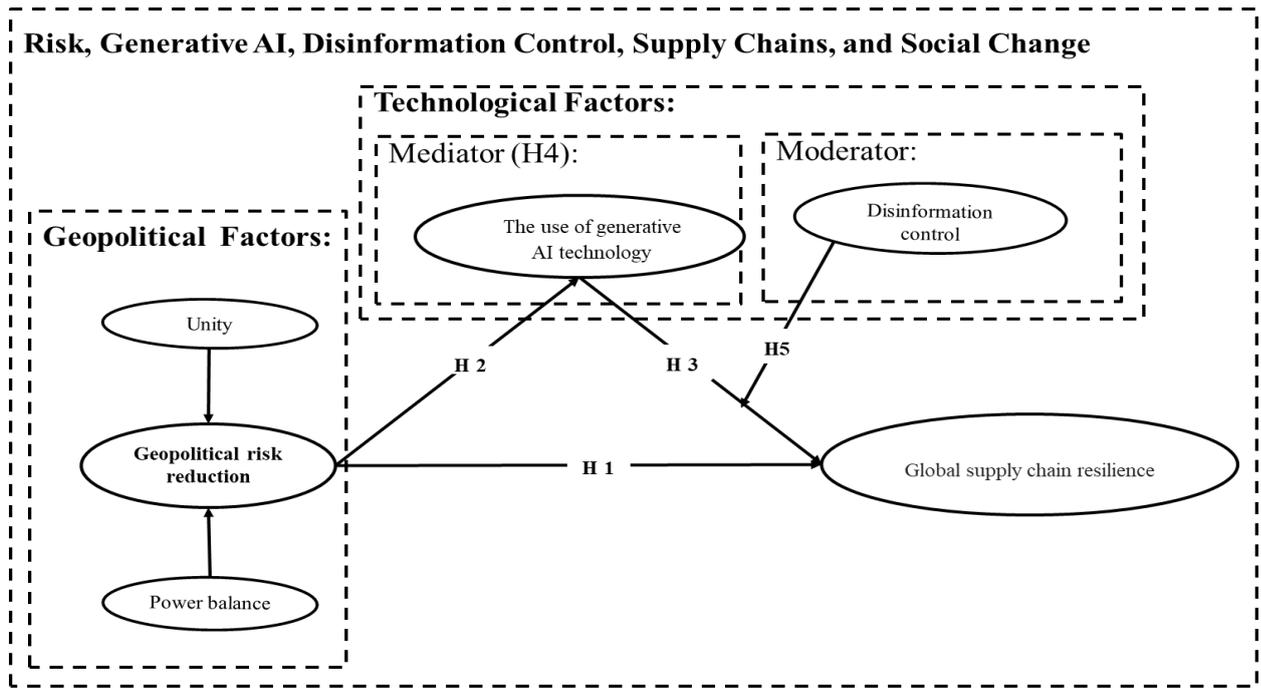
In summary, we believe that controlling disinformation is the key with the help of GenAI. This control can create an impact on the global supply chain resilience. Effective and efficient disinformation control can boost the positive effects of AI on transparency, demand forecasting, and risk management in supply chains. By limiting the harm caused by disinformation, companies can make the most of GenAI to build stronger global supply chains. Based on these points, we developed the following hypothesis. Figure 1 shows how the main ideas are connected, and Table 1 summarises the previous studies.

**H5.** *AI-led disinformation control moderates the relationship between the use of generative artificial intelligence technology and global supply chain resilience.*

Table 1: Synthesis of prior studies on geopolitical risk, global supply chain resilience, and AI/GENAI in operations

Study	Key Constructs	Method	Context	Principal Findings	Study Differences & Advances
Roscoe et al. (2020)	Geopolitical uncertainty, supply chain redesign	Case studies (Brexit)	UK manufacturing	Risk triggers nearshoring; no resilience mechanism	Adds GRR via BPT, tests mediation by GenAI
Bednarski et al. (2024)	Geopolitical disruptions, vulnerability	Literature review	Global SC	Classifies risks; no firm-level reduction model	Introduces GRR as 2nd-order construct (unity + powerbalance)

Study	Key Constructs	Method	Context	Principal Findings	Study Differences & Advances
Ali et al. (2024)	Leadership style, logistics innovation	Survey (n=312)	Global logistics	Leadership drives innovation under disruption	Links GRR to resilience via GenAI, not leadership
Ivanov et al. (2021)	Digital twins, resilience	Simulation	General SC	Digital tech buffers shocks	Empirical test of GenAI mediation in real firms
Li et al. (2024)	GenAI, sustainable SC performance	PLS-SEM (n=unknown)	General	GenAI improves performance	Adds disinformation control moderator, shipping context
Akhtar et al. (2023)	Disinformation, AI detection	Conceptual + case	General SC	AI detects fake news	Tests moderation on GenAI → resilience link
Jackson et al. (2024)	GenAI capabilities (learning, prediction)	Framework	SCOM	GenAI enables agility	Empirical validation in maritime, BPT grounding
<b>This Study</b>	<b>GRR (unity + power balance), GenAI use, Disinformation control, GSCR</b>	<b>PLS-SEM (n=209)</b>	<b>Chinese maritime (Shanghai, Ningbo, Qingdao)</b>	<b>GRR → GSCR; GenAI partial mediation; Disinformation control moderation</b>	<b>First to: (1) Apply BPT at firm level, (2) Model GRR as 2nd-order, (3) Test GenAI mediation + disinformation moderation in shipping</b>



**Fig.1.** The relationships between the study constructs

### 3. Methodology

#### 3.1. Participants, data, and common method bias

To explore the relationships between our various variables and constructs of interest, we employed a quantitative method and approach involving a cross-sectional survey approach. According to Nardi (2018), quantitative research helps investigators to collect data from selected populations to address underlying questions or hypotheses. This approach enables the collection of statistically significant data, which can then be analysed to identify patterns, trends, and correlations within the population. Similarly, Zhang et al. (2021) argued that quantitative research is suited to test theories and hypotheses to examine the interactions between constructs. Therefore, we collected our study's data through a self-manage online survey, measuring all research model variables based on primary data.

The context for our study was the maritime logistic sector. Specifically, we collected data on Chinese ocean freight and maritime logistics from the following subsectors: shipping and freight services, port operations, and maritime support services. China's gross ocean product (GOP) has reached 9 trillion RMB (approx. 1.27 trillion USD), growing by 128% since 2010 to represent about 8% of the national GDP (Zheng et al., 2023). Globally, the world's second-largest shipping domain is controlled by China in terms of gross tons and its logistics market is the largest in the world, with a value surpassing 352 trillion yuan (approx. 49.62 trillion USD) in 2023 (e.g., Blanchette et al., 2020; Zhang, 2024). According to the latest of UNCDAT maritime transport indicators report (2023), China is the best-connected country in terms of liner shipping connectivity, with the Shanghai, Ningbo, and Qingdao ports being positioned among the top five best-connected ports globally. In 2022, China's ports handled a significant volume of container traffic—for example, the port of Shanghai alone managed over 47 million twenty-foot equivalent units (TEUs). The facts and figures related to Chinese ocean freight and maritime logistics provide a valuable foundation for the exploration of GRR and GSCR applications in the context of the circular economy, with the use of GenAI technologies serving as a catalyst and disinformation control offering adaptive flexibility.

Table 2 outlines the characteristics of our research participants. To obtain a wide range of perspectives from a substantial dataset, we chose managers operating in the Chinese ocean freight and maritime logistics’ subsectors—shipping and freight services, port operations, and maritime support services—in Shanghai, Ningbo, and Qingdao.

Table 2: Demographic attributes of respondents

Categories	Characteristics	Count	Percentage (rounded)
Gender	Male	121	58
	Female	88	42
Education	College level	61	29
	Bachelor	94	45
	Masters	54	26
City	Shanghai	96	46
	Ningbo	62	30
	Qingdao	51	24
Subsector	Shipping and freight services	99	47
	Maritime support services	67	32
	Port operations	43	21
Job Title	CEO/COO/CTO	7	3
	Crew manager	22	11
	Customer service manager	34	16
	General manager	9	4
	Health, safety, environmental, quality assurance manager	12	6
	Operations manager	23	11
	Logistics/supply chain manager	27	13
	Marine support services manager	9	4
	Port manager	11	5
	Port/ port operations manager	23	11
	Sea freight procurement manager	11	5
	Ship management centre director	12	6
	Terminal manager	9	4
Experience	3 to 5 years	46	22
	6 to 10 years	96	46
	11 years and more	67	32

n=209

Before distributing our survey, we followed ethical guidelines and got informed consent from everyone who might participate. We used purposive sampling to select people who fit our specific criteria. The inclusion criteria were:

We built our sampling frame using industry directories, such as China Maritime Association member lists and port authority registries for Shanghai, Ningbo, and Qingdao, as well as LinkedIn professional network. Initially, the pool of 1,231 managers meeting the inclusion criteria (top/mid-level with 5+ years experience in the specified subsectors). All available information i.e. contact information etc was verified via company websites and emails.

To evaluate the quality of our data, we employed two methods. First, we employed non-response bias. To counter the non-response bias, we conducted a wave analysis. We compare the early responders (first quartile,  $n=52$ ) with late responders (last quartile,  $n=52$ ) using independent t-tests across all constructs (Armstrong & Overton, 1977). We found no significant differences were found (all  $p > 0.05$ ; e.g., GRR:  $t=0.85$ ,  $p=0.40$ ; GenAI:  $t=1.12$ ,  $p=0.27$ ). It provided stronger evidence against non-response bias.

Second, we assess the possibility of common method bias in our study. For common method bias (CMB), we used the marker variable analysis using a theoretically unrelated marker (attitude toward social media advertising, unrelated to geopolitical/supply chain constructs). We found low correlations (e.g., marker > GSCR = 0.031; marker > GenAI = 0.068), indicating minimal CMB risk. Additionally, Harman's single-factor test showed the first factor explaining only 28.4% of variance (below 50% threshold) confirming low CMB.

The study's cross-sectional design limits causal inference and minimize the endogeneity risks e.g. reverse causality or omitted. We interpret results as associations rather than causation. Potential endogeneity from self-selection into GenAI adoption was assessed via Heckman correction in robustness checks (see Section 4.3). It showed with no significant bias.

### *3.2. Tools and procedures*

Through an extensive literature review, we found and selected the pertinent concepts, theories and measures for the variables in present study—i.e., GRR, the use of GenAI technology, disinformation control, and GSCR. We defined these variables using multi-item measures, carefully adapting them, according to the specific context of the Chinese ocean freight and maritime logistics sectors. Additionally, to safeguard the precision of study data and to mitigate (any) risk of survey questionnaire misspecification, screening questions were included in study instrument. We employed a five-point Likert scale for our survey. We used a scale from 1 (disagree) to 5 (agree) to record participants response on various statements. It helped us capture subtle differences in managers' answers. We conducted exploratory factor analysis and used metrics such as average variance extracted (AVE) and composite reliability (CR) to assess the validity of study variables (Hair et al., 2020). We defined GRR as a two-part, second-order construct. The unity dimension measured how closely countries work together and how much they share a vision when facing common challenges. The power balance dimension showed how much a few countries control market rules and resources. We used five and six items to assess unity and power balance, respectively. The unity sub-construct was adapted from Castañer and Oliveira (2020) and Devi et al. (2023), and the power balance sub-construct from Graham and Serdaru (2020) and Hong (2020).

GRR reflected the level of cooperation and fair resource-sharing needed for a stable, fair industry. The internal consistency scores for unity and power balance were 0.799 and 0.805, respectively. The use of GenAI technology construct, adapted from Akhtar et al. (2024), measured the degree to which businesses create and personalize ideas, ensuring they meet market requirements and increase the efficiency of operations. This construct involved eight items, and the internal consistency of its scales was found to be 0.843. The AI-led disinformation control construct represented the degree whereby the authenticity of the information was assured and the effectiveness of the supporting regulatory measures enacted by the authorities. Disinformation control, for which we adopted five items from Chaudhuri et al. (2024), yielded an internal consistency of 0.854. The GSCR construct measured the speed with which the global supply chain flows had recovered after the disruption(s). We assessed this construct with four items adapted from Akhtar et al. (2022). It is determined that the internal consistency was 0.828. In summary, all internal consistency values exceeded the minimum suggested threshold of 0.70, thereby confirming the reliability (Ali et al., 2024; Hair et al., 2021). Detailed information about the constructs and relative items can be found in Appendix A.

The second-order GRR construct is specified as a reflective–reflective model. It consists of two first-order reflective dimensions, unity and power balance. They load onto the higher-order GRR construct. Identifiability is achieved through the repeated indicators approach in PLS-SEM. In this method, the same items used at the first-order level are applied again at the second-order level, following the guidelines of Becker et al. (2012). Convergent validity for GRR is established with second-order AVE = 0.58 (>0.50) and CR = 0.82 (>0.70). It indicates that the dimensions explain sufficient variance in GRR. Discriminant validity is confirmed via HTMT ratios: GRR vs. GenAI = 0.62, GRR vs. DC = 0.51, GRR vs. GSCR = 0.68 (all <0.85). Fornell-Larcker criterion, where GRR's square root AVE (0.76) distinguishes GRR as proactive equilibrium-seeking.

## 4. Results

### 4.1. Measurement model results, validity, and reliability

We carefully evaluated both validity and reliability to check the effectiveness of our results and measurements. We assessed convergent validity by examining factor loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). Together, these measures show that the indicators are closely linked to their constructs, supporting internal consistency, reliability, and the extent to which the constructs explain the variance in their indicators. Hair et al. (2016) and Akhtar et al. (2023), proposed a standard (minimum) loading value of 0.60 of Cronbach's alpha and composite reliability. Furthermore, it is recommended that AVE values exceed 0.5 to effectively measure the relationships within the construct (Meena et al., 2023). The study results produced good loadings, Cronbach's alpha and CR values. Moreover, we observed that the AVE measurement for study constructs surpassed the (minimum) threshold of 0.50. As a result, it is confirmed that the measurement study (proposed) model fully satisfied all advised validity accuracy and reliability consistency criteria. Later, we measure the HTMT values by test to ensure discriminant validity through determining the proportion of correlation between the constructs (Guenther et al., 2022). All the HTMT values (Table 3) were found to be lower than 0.85, suggesting that all constructs were reasonably distinct and not overly correlated (e.g., Hair et al., 2021). This indicates that our research models effectively differentiate between the concepts being measured. The particulars of all indications and figures are mentioned in Table 3 and Fig.2.

Table 3: Outcomes of the confirmatory composite analysis

Construct	Factor Loadings	CR	AVE	HTMT
Geopolitical risk reduction				
Unity				
GRR1	0.832	0.801	0.553	< 0.85
GRR2	0.813			
GRR3	0.794			
GRR4	0.711			
GRR5	0.784			
Power balance				
GRR6	0.867	0.813	0.555	< 0.85
GRR7	0.793			
GRR8	0.835			
GRR9	0.797			
GRR10	0.813			
GRR11	0.803			

Global supply chain resilience

GSC1	0.794	0.775	0.566	< 0.85
GSC2	0.796			
GSC3	0.863			
GSC4	0.878			

The use of GenAI technology

GAI1	0.713	0.852	0.644	< 0.85
GAI2	0.896			
GAI3	0.891			
GAI4	0.853			
GAI5	0.766			
GAI6	0.794			
GAI7	0.893			
GAI8	0.874			

AI-led Disinformation control

DC1	0.854	0.896	0.631	< 0.85
DC2	0.867			
DC3	0.743			
DC4	0.874			
DC5	0.799			

Legend - CR=composite reliability, AVE=average variance extracted, HTMT=hetero-trait-monotrait ratio of correlations

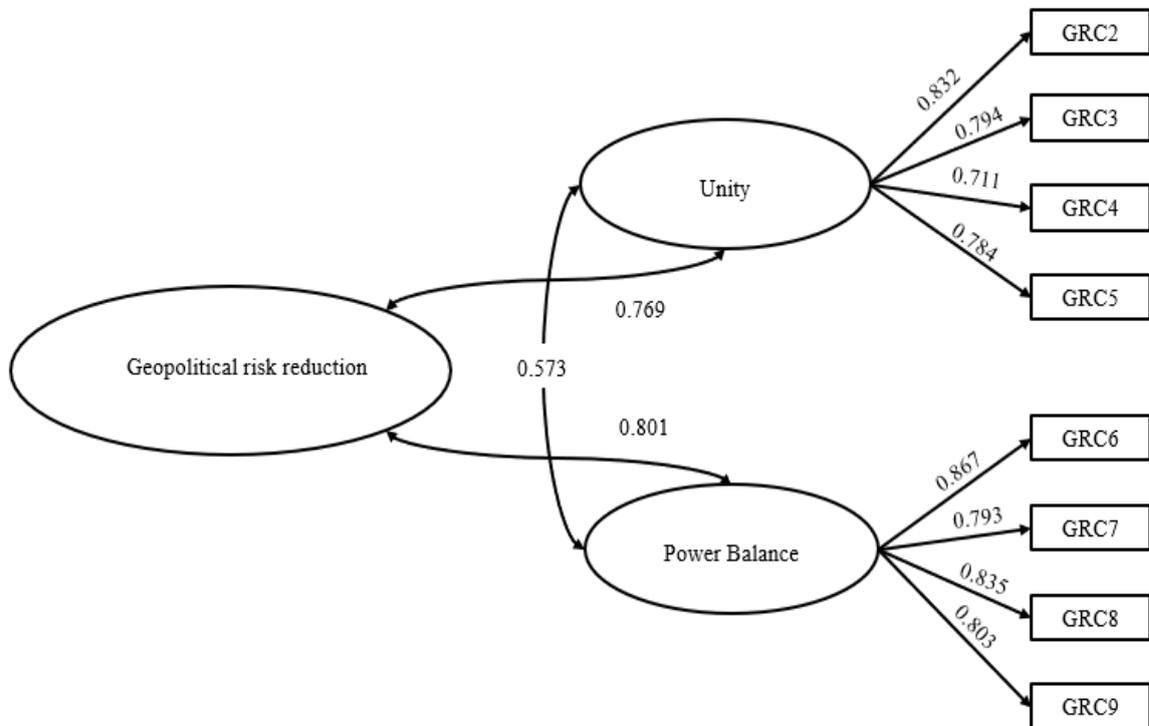


Fig. 2. The construct, correlations, and loadings

#### 4.2. Structural model and hypothesis results

Following the suggestions made by Hair et al. (2019) and Akhtar et al. (2023), we applied standardized research methodologies to both present our findings and rigorously assess the hypotheses underlying our structural research model. These procedures help keep our reporting consistent, reliable, and clear, and they provide a strong framework for testing our hypotheses in this study. We found a significant direct link between GRR and GSCR, which means that lowering geopolitical risks can improve supply chain resilience (GRR → GSCR ( $\beta = 0.45$ ,  $t = 6.12$ ,  $p < 0.01$ , 95% CI [0.32, 0.58])). This supports H1. Table 4 shows the beta and t-values for each hypothesis. We also found that GRR strongly encourages the use of GenAI technology, showing that organizations are using AI to manage geopolitical risks, which supports H2 (GRR → GenAI ( $\beta = 0.38$ ,  $t = 5.45$ ,  $p < 0.001$ , 95% CI [0.25, 0.51])). Our results also show a significant direct link between using GenAI technology and GSCR, confirming that GenAI can help make supply chains stronger (GenAI → GSCR ( $\beta = 0.32$ ,  $t = 4.78$ ,  $p < 0.01$ , 95% CI [0.19, 0.45])). This supports H3. We used a forward statistical approach to study these links and found significant results in all four models, even after accounting for organizational type and subsector. We conducted mediation analysis using the methods described by Ghouri et al. (2023) and Sharma et al. (2021). We also saw a notable drop in the t-value for GenAI use, which shows the importance of the indirect relationship through GenAI, which is partly mediated.

Table 4: Model specifications, structural outcomes, and fit metrics

Constructs/ Hypotheses	$\beta$	t-value	p-value	95% CI
GRR → GSCR (H1)	0.45	6.12	<0.001	[0.32, 0.58]
GRR → GenAI (H2)	0.38	5.45	<0.001	[0.25, 0.51]
GenAI → GSCR (H3)	0.32	4.78	<0.001	[0.19, 0.45]
GRR → GAI → GSCR (H4)	0.12	3.21	<0.01	[0.06, 0.20]
DC x GenAI → GSCR (H5)	0.15	2.89	<0.01	[0.04, 0.26]

$R^2$  (GSCR) = 0.42;  $Q^2$  = 0.28; SRMR = 0.065

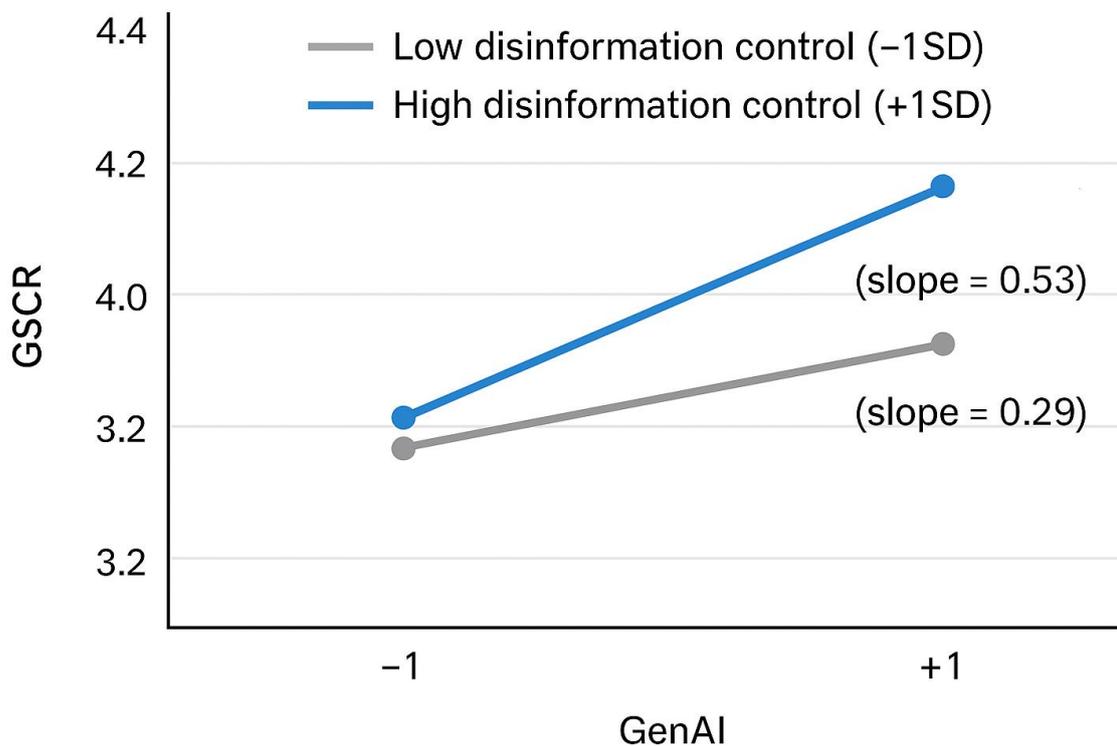
Note:

Abbreviations: GRR – Geopolitical risk reduction, GenAI - Use of generative artificial intelligence technology, DC – Disinformation control GSCR: Global supply chain resilience

We conducted mediation analysis using the methods described by Ghouri et al. (2023) and Sharma et al. (2021). We observed a significant decrease in the t-value associated with the use of GenAI technology. This indicates the significance of the indirect relationship through the use of GenAI technology. This relationship is partially explicitly mediated for H4 (Indirect effect  $GRR \rightarrow GenAI \rightarrow GSCR$  ( $\beta = 0.12$ ,  $t = 3.21$ ,  $p < 0.01$ , 95% CI [0.06, 0.20])). The results show the partial mediation as direct path remains significant (variance accounted for = 39%).

Lastly, we applied the ‘product indicator’ technique, as used by Zitzmann and Helm (2021), to assess the moderating role of disinformation control. Our results were found to demonstrate that disinformation control plays a significant moderating role, suggesting its imperative role in the utilization of GenAI and its relative social impacts, ultimately making social change. we offer a graphical aid of the connection stated in H5 ( $DC \times GenAI \rightarrow GSCR$  ( $\beta = 0.15$ ,  $t = 2.89$ ,  $p < 0.01$ , 95% CI [0.04, 0.26])) and developed a graphical depiction. Fig.3 depicting a high presence of disinformation control in the use of GenAI enhances GSCR and relative community. GSCR is directly connected to social impacts such as affecting prices, costs, delays - ultimately society at large suffers.

The results provide strong supporting evidence for the hypothesis that GRR can enhance GSCR, both directly and indirectly through the adoption of generative AI technology. Disinformation control also significantly moderates these relationships. The findings highlight the importance of strategic geopolitical risk management and the potential benefits of leveraging GenAI to bolster GSCR.



**Fig. 3.** Moderation effect of AI-led Disinformation Control

#### 4.2.1. Model fit claims

Table 4 shows the fit indices for the model i.e.  $R^2$ ,  $Q^2$ , SRMR. All indices exceeded acceptable thresholds, indicating a strong model fit (e.g., Donkor et al., 2021).

### 4.3. Estimation approach, software, and robustness checks

We employed partial least squares structural equation modeling (PLS-SEM) using SmartPLS 4.0 software. This software was suitable for our complex model with a sample size of 209 responses. The research model of the study has second-order constructs, mediation, moderation focus on prediction/explanation over covariance fit (Hair et al., 2021). The PLS-SEM software was chosen over covariance-based SEM (CB-SEM) due to non-normal data (Shapiro-Wilk  $p < 0.05$  for most items). Data had exploratory elements in GenAI/disinformation links, and emphasis on path significance rather than global fit. Settings: Consistent PLS algorithm, 5,000 bootstraps, no sign changes, complete bootstrapping.

PLS-specific diagnostics: SRMR=0.065 ( $< 0.08$  threshold, good fit);  $R^2$  values (GSCR=0.42, GenAI=0.35, indicating moderate explanatory power);  $Q^2$  (Stone-Geisser predictive relevance) via blindfolding: GSCR=0.28, GenAI=0.22 ( $> 0$ , predictive); Variance inflation factors (VIF) for predictors  $< 3.0$  (e.g., GRR=1.45, GenAI=1.62, no multicollinearity). For mediation (H4), bias-corrected 95% CIs [0.06, 0.20] exclude zero (partial mediation). For moderation (H5), product-indicator CIs [0.04, 0.26] exclude zero. Robustness: Heckman two-step for endogeneity (using firm size as instrument) showed no correction needed; multigroup analysis by subsector confirmed invariant paths (MICOM  $p > 0.05$ ). Previously reported CB-SEM indices (e.g.,  $\chi^2/df$ ) were exploratory and have been removed as inconsistent with PLS-SEM.

### 4.4. Detailed moderation analysis procedure and interpretation

The moderation (DC x GenAI  $\rightarrow$  GSCR) was estimated using the product-indicator approach in PLS-SEM (Zitzmann & Helm, 2021; Hair et al., 2021). The indicators DC and GenAI were mean-centered to reduce multicollinearity (VIF  $< 2.5$  post-centering) and multiplied to form interaction terms.

Consistent PLS algorithm in SmartPLS 4.0, with 5,000 bootstraps for bias-corrected CIs. Effect size  $f^2 = 0.05$  (small but significant per Cohen, 1988). Simple slopes: At high DC (+1 SD), slope = 0.53 ( $t=5.12$ ,  $p < 0.001$ ); at low DC (-1 SD), slope = 0.29 ( $t=2.89$ ,  $p < 0.01$ ), indicating stronger positive GenAI-GSCR link under high DC. Regions of significance via Johnson-Neyman: Interaction significant for DC  $> -0.82$  (78% of sample), non-significant below.

## 5. Discussion and conclusion

### 5.1. Theoretical implications

The interlocks among geographical risk, generative artificial intelligence, disinformation control, global supply chains, relative social impacts and contemporary social change are complex. We have endeavoured to disentangle these interlocks by investigating the underlying relationships. There is no doubt that geopolitical risk is one of the greatest threats to society and supply chain players. In some cases, such risk causes famine, hunger, and deaths. Additionally, the roles generative artificial intelligence and disinformation control are not only interesting but also play a significant part in shaping social perceptions and finding relative truth, which are affected by fake news/disinformation (Akhtar et al., 2023; Chatterjee et al., 2023; Petratos and Faccia 2023; Spanaki et al., 2023; Ma et al., 2025). The responsible use of generative artificial intelligence by controlling disinformation is extremely crucial. Although there are many benefits of using generative artificial intelligence, it can create fake news and fake images that are hard to even recognize either they are real or fake.

Our findings support H1 by showing a direct positive association between geographical risk reduction and global supply chain resilience. This association is consistent with Roscoe et al. (2020), who found that geopolitical stability enables supply chain redesign but did not

model firm-level risk reduction mechanisms. We advance by operationalizing GRR, unlike Bednarski et al. (2024)'s vulnerability classification, as a second-order construct under balance of power theory. The unity (e.g., firm coalitions) and power balance (e.g., equitable regulations) explain the geographical risk reduction and highlight the external equilibrium over internal adaptations like dynamic capabilities (Teece et al., 1997).

For H2 and H3, geographical risk reduction encourages generative artificial intelligence use which in turn boosts global supply chain resilience. These findings extend Li et al. (2024)'s general generative artificial intelligence-performance link to a mediated pathway in maritime firms. This contrasts with Ivanov et al. (2021)'s simulation-based digital tech buffering. Our empirical results in H4 show partial mediation, implying generative artificial intelligence acts as a firm-level balance of power theory mechanism for risk mitigation in contested routes.

H5's moderation findings align with Akhtar et al. (2023)'s AI-disinformation detection. It shows that disinformation control strengthens generative artificial intelligence and global supply chain resilience links. Our findings support recent studies that suggest the importance of generative artificial intelligence on supply chain performance (Dubey et al., 2024; Li et al., 2024). At the same time, our study extends knowledge by demonstrating the efficacy of generative artificial intelligence in reducing geopolitical risk and enhancing supply chain resilience. This is an important contribution because the contextualised effectiveness of generative artificial intelligence in supply chains is still in its infancy (Dubey et al., 2024; Li et al., 2024). Furthermore, our study extends our knowledge by examining the role of AI-based disinformation control. It is strengthening the effects of generative artificial intelligence on supply chain resilience in maritime operations. This is another important contribution and addition to theoretical knowledge, given that fake news and disinformation have consistently disrupted supply chains and made their operations unsustainable (Akhtar et al., 2023; Chatterjee et al., 2023; Petratos and Faccia, 2023; Spanaki et al., 2023). Disinformation can make geopolitical crises harder to manage. AI technologies can help to control over the impact of disinformation. Managing these risks is key to keeping supply chains running smoothly. Our findings show that using AI to control disinformation boosts the positive effects of GenAI on supply chain resilience. When disinformation is managed well the generative artificial intelligence has an even stronger impact on resilience.

Study results suggested that Balance of Power Theory components unity and cooperation play a critical role in shaping geopolitical relations and ultimately supply chain. Furthermore, results explained that states and firms should build the strategic partnerships. This helps connect different supply chain networks in different regions and industries. Firms should capitalise the generative artificial intelligence's advanced capabilities in decision making, identify risks and vulnerabilities in their supply chains through learning, prediction, interaction and reasoning (e.g., Jackson et al., 2024). This improves both efficiency and resilience in supply chain networks.

## *5.2. Practical implications*

*For practitioners and policymakers, our findings have several implications. Supply chain managers should prioritise strategic partnerships, either at the country level or within free-market industry alliances. Such unity and cooperation can enable access to critical locations within a specific country or industry and help firms gain a competitive edge.*

*Managers should also design fair and balanced processes and dealings so that supply chains remain agile during disruptive periods. In many cases, firms will need to collaborate with governments, regulators, industry associations, and other stakeholders to build strong international relationships. They can leverage generative artificial intelligence to identify risks in their supply chains and turn these risks into opportunities to strengthen resilience. Policymakers can support these efforts by promoting AI-based risk prediction capabilities and by providing accurate information and resources about conflict-prone areas. Strengthening the link between generative artificial intelligence and disinformation control can, in turn, make maritime supply chains more robust.*

*Our empirical results suggest several concrete action points for China's maritime industry. Major ports such as Shanghai handle around 47 million TEUs, and our analysis shows that a one-unit increase in GRR is associated with a 0.45-unit increase in GSCR. This effect could translate into transit delay reductions of up to 30% in Red Sea-type disruptions (Morgan, 2024). Carrier managers should therefore use generative artificial intelligence-based predictive analytics to support rerouting decisions in high-GRR contexts. A one standard deviation increase in disinformation control can increase resilience by up to 82%. Regulators such as the China Maritime Association could mandate disinformation-control protocols and introduce standards. These measures would help restore a more balanced distribution of power in port operations and further strengthen maritime supply chain resilience.*

*Having reliable GenAI systems provide practical advantages over competitors, enhancing supply chain resilience through better end-to-end supply chain visibility. Many firms nowadays trying to build their internal GenAI systems to enhance additional employees' productivity and saving their time for routine tasks, as such systems help them to automate tasks. Additionally, such internal systems safeguard confidential data without leaving firms' premises, thus, GenAI is new oil for managers to utilize for competitive advantages.*

### *5.3. Conclusion*

Our results indicate that generative artificial intelligence is building supply chain resilience under conditions of geopolitical tension and disinformation. It helps organisations to respond to changing conditions and refine supply chain operations. In complex systems, generative artificial intelligence supports efficiency and resilience by continuously updating its inputs based on current and future trends (Jackson et al., 2024). Moreover, the positive effect of generative artificial intelligence on resilience is amplified when disinformation is controlled effectively. This relationship reinforces the robustness of maritime supply chains. Firms can reduce geopolitical tensions through their supply chain networks. Adopting new technologies could be a challenge for the firms. Firms and technologies alone or together are not only exposed to disruptions but also contribute to them.

### *5.4. Limitations and future research directions*

Our study has several limitations that future research could address. Theoretically, scholars could further explore the drivers of geopolitical risk reduction, such as social or political engagement, when developing risk management strategies. Another promising line of inquiry concerns the role of responsible AI in building supply chain resilience during geopolitical disruptions.

Methodologically, our cross-sectional design limits our ability to make strong causal claims and raises the possibility of reverse causality (for example, more resilient firms may be more inclined to adopt generative artificial intelligence in the first place). Future studies

could employ longitudinal designs in Chinese ports to track changes in GRR, generative artificial intelligence use and resilience over time. In addition, our findings are specific to China's maritime sector during a period of U.S.–China tensions, which may constrain their generalisability to other regions, such as EU shipping. Comparative studies across regions and using different methodological approaches would therefore be valuable.

Qualitative research based on interviews or case studies could also provide deeper insights into how geopolitical risk reduction, generative artificial intelligence use, disinformation control and resilience are enacted in day-to-day operations. Particularly, the applications of agentic AI will be more interesting, as such systems have better capabilities to sense surrounding environments and then react accordingly. Longitudinal studies could capture the dynamic nature of supply chain resilience and reveal how firms actually cope with crises over time. In this context, future research could draw on evidence from firms exposed to different types of geopolitical risk and compare how resilience strategies and outcomes vary across risk profiles.

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## Appendix-A

Constructs	Brief item descriptions
<i>Geopolitical risk reduction:</i>	
1) <i>Unity Power balance</i>	<i>Unity dimension</i> 1) Our organization frequently collaborates with other companies in the industry to address common challenges faced by our countries. 2) Our organization and its partners share a common vision for the future of the industry between friendly countries. 3) There is a high level of trust between our organization and its industry partners operating in other countries. 4) We provide mutual support to our partners in times of crisis arising in our global operations. 5) Our organization actively shares information with other friendly countries to improve collective decision-making for unity.
2) <i>Power balance dimension</i>	1) Key countries have a disproportionate influence over industry regulations. 2) Resources within the industry are distributed unevenly, favouring certain countries. 3) Our organization often faces challenges in accessing critical resources compared to larger competitors from dominating countries. 4) Decision-making authority within the industry is concentrated by a few dominating countries. 5) A few countries dominate the market, making it difficult for others to compete. 6) Market power is heavily skewed towards certain countries in the industry.
<i>The use of generative artificial intelligence technology</i>	1) Our team applies GenAI [e.g., ChatGPT,] to provide personalized operations. 2) Our team uses GenAI-based analytics for service innovation for personalization and customization. 3) We employ GenAI for risk identification in our processes. 4) We utilize GenAI to upgrade our processes as per customer requirements. 5) Our team integrates AI-based solutions to improve related services. 6) We consider AI to be our major strategy for operational innovation. 7) We use AI in our processes to optimize logistics 8) We use robotic process automation in our logistical processes.
<i>Disinformation control</i>	1) Our staff frequently tackles misinformation on social media platforms. 2) Handling misinformation significantly increases trust in social media platforms. 3) Current tools (e.g., fact-checking, reporting) are effective in identifying and managing misinformation

- 4) Our staff likely to verify the accuracy of information before sharing it with others.
- 5) Our staff support regulatory measures to hold our teams accountable for misinformation.

*Global supply chain  
resilience*

- 1) Our global supply chain flows are quickly restored.
  - 2) We do not take long to recover from global supply chain crisis.
  - 3) Our global supply chain promptly bounces back to its original state, maintaining our resilience against crisis
  - 4) We often effectively deal with global supply chain disruptions.
-

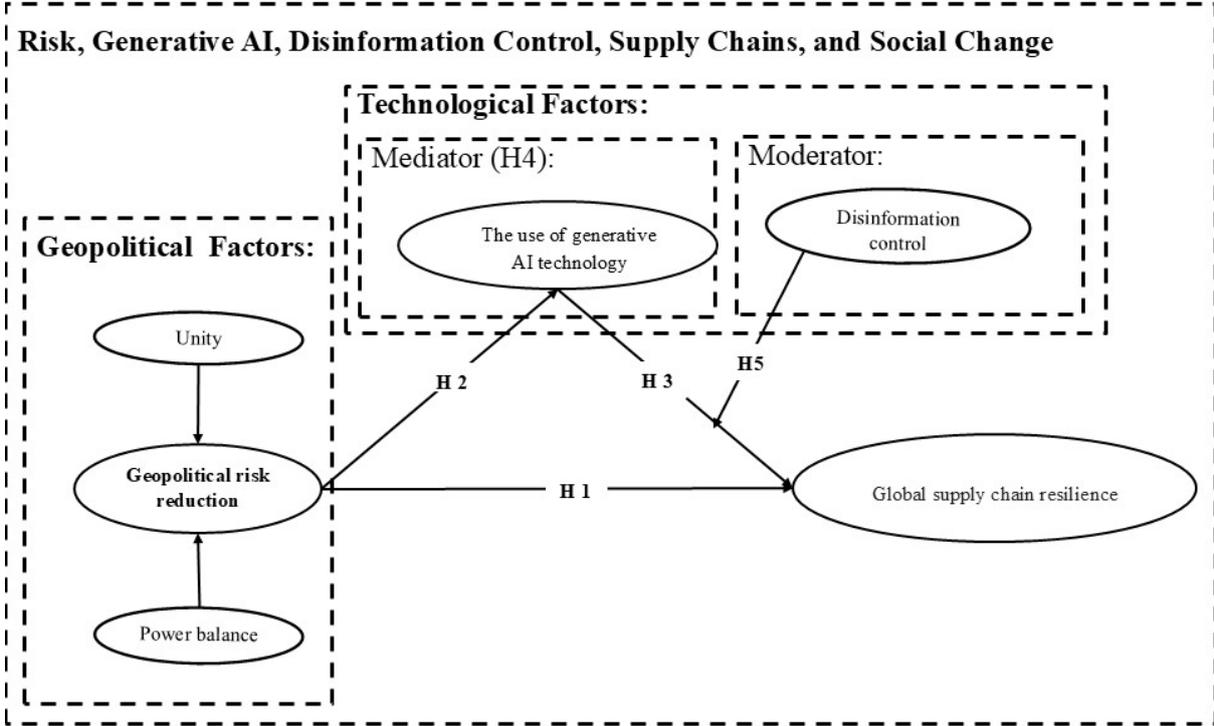


Fig.1. Relationships between the underlying constructs

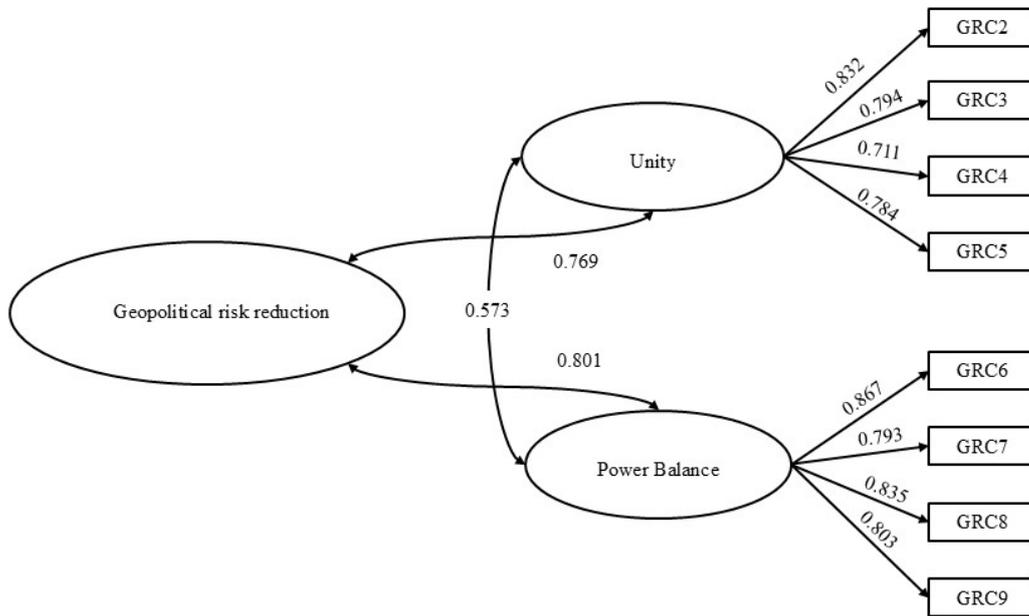


Fig. 2. The second-order construct, correlations, and loadings