

# Logistics flow disruptions through the Suez Canal: enhancing supply chain risk management and resilience

Daniel Simon

Budapest Business School, Buzogány u. 10-12, 1149, Budapest, Hungary, EU, ORCID: 0000-0001-8333-8936, daniel.simon.50@unibge.hu

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**Abstract:** The study examines the Suez Canal's crucial role in global supply chains and the consequences of its disruptions, focusing particularly on the 2021 ship blockage and the escalation of the Red Sea conflict from 2023. It investigates these events from a supply chain resilience perspective, exploring risk mitigation strategies and responses to arising risks. The methodology includes an extensive literature review on Suez Canal disruptions and their cascading, global effects. Qualitative data were gathered through semi-structured interviews with six raw material procurement planners from a European multinational production company, responsible for managing goods flow from North America and Asia-Pacific to Europe. The interviews and a dedicated workshop were transcribed and thematically analysed using NVivo software. Findings offer valuable insights into the effects of disruptions on global supply chains, highlighting significant delays in supplier awareness of critical global events, and emphasizing the importance of effective communication, continuous risk management, and maintaining safety stocks. The study also identifies lessons from past disruptions, suggesting strategies to enhance supply chain visibility, diversifying transportation routes, while promoting the importance of sustainability, and strengthening supplier relationships. This research addresses a critical logistics topic by focusing on the 2023–2024 Red Sea conflict and aims to bridge a gap in the existing literature regarding supply chain resilience and risk management related to Suez Canal disruptions. By incorporating firsthand industry experiences, the study offers original, practical insights for mitigating the impact of such disruptions on global supply chain operations.

## 1 Introduction

The Suez Canal, a critical link between the Mediterranean Sea and the Red Sea, has long been recognized as a strategic chokepoint in global logistics and trade. Since its construction in 1869, the Canal has facilitated international shipping and significantly influenced global economy. The Canal offers a direct route between Europe and Asia without a long voyage for ships around the Cape of Good Hope, thereby reducing delivery times and costs [1]. In 2022, the canal handled about 12% of global trade and accommodated nearly 22,000 ships [2]. According to annual reports by the Suez Canal Authority, the canal helps transport goods worth over \$1 trillion each year [3,4]. The significance of the Canal goes beyond economic value, and it plays a crucial role in maintaining efficient, reliable supply chains. As the Canal shortens delivery times and lowers transportation costs, it is often the preferred route for many shipping lines. Although it primarily connects Asia and Europe, its strategic importance also makes it a vulnerable point in the global supply chain. Recent disruptions, most notably the Ever Given blockage in March 2021 and the intensifying Red Sea conflict in 2024, have underscored the canal's critical function and the serious consequences such events can have on global trade and logistics. These disruptions extend beyond immediate logistical challenges, affecting overall resilience in global supply chains. As a result, having strong risk management strategies and contingency plans is essential to keep operations running smoothly in the face of such disruptions. This research examines recent

disruptions in the Suez Canal and explores how organizations are learning from these events to improve their supply chain resilience against similar risks.

To fully address the importance of the Suez Canal and how its disruptions impact global supply chains, this study involves a detailed review of existing literature on the canal's role in worldwide commerce. Next, it employs a single-organization case study that collects qualitative data from individual semi-structured interviews and a group workshop involving six raw material procurement planners. These planners were selected on the basis of their relevant positions: they manage supply chains for a European multinational production firm, specifically handling raw materials transported from the Asia-Pacific and North America regions to Europe. The interviews were transcribed and analysed using thematic coding in NVivo. The results chapter identifies recurring themes and patterns from the participants' viewpoints. This approach offers a detailed understanding of the impacts and lessons learnt from those directly affected by Suez Canal disruptions.

The main goal of this research is to explore and collect practical experiences of raw material planners who faced difficulties caused by Suez Canal disruptions. By focusing on real-life scenarios and hands-on strategies, the study aims to broaden and compare the existing, limited research on how risk management and supply chain resilience are influenced by logistical disruptions, especially focusing on sea freight transportation of raw materials through the Suez Canal. This approach ensures a steady production flow for organizations. The central research question is the

following: What are the common experiences and practical steps an organization can take to reduce the impact of potential disruptions in raw material transportation through the Suez Canal to ensure uninterrupted production flow?

## 2 Literature review

The construction of the Suez Canal began in 1859 under the guidance of the French diplomat Ferdinand de Lesseps and was completed in 1869. This major engineering project aimed to reduce the maritime distance between Europe and Asia [1]. The canal operates as a sea-level waterway without locks, allowing ships to move directly between the Mediterranean Sea and the Red Sea. Its design, featuring bypasses and double sections, enables vessels to transit in both directions at the same time [5]. Since its opening, the Suez Canal has undergone multiple expansions and upgrades to handle bigger ships and increase trade volumes. Notably, the 2015 expansion, called the New Suez Canal, significantly raised the canal's capacity, allowing more ships to pass daily and further reducing transit times [6]. These advancements have ensured the canal's status as a critical link in global trade and logistics. As of 2024, the canal remains a cornerstone of maritime traffic, supporting the transport of oil, liquefied natural gas (LNG), raw materials, and finished goods between Europe, Asia, and the Middle East [2,7,-9]. On average, the canal shortens routes from key Asia-Pacific ports to Europe by 12 days compared to sailing around the Cape of Good Hope [8,9]. The distance to be covered from Singapore to Rotterdam is reduced from 14,000 nautical miles to just 10,000 nautical miles. In 2022, the use of the canal saved transportation companies an estimated \$5 billion in fuel and related costs, highlighting the economic benefits of this shorter route [3]. Also in 2022, approximately 22,000 ships passed through the canal [2]. The total value of goods moving via the canal reached more than 1.6 billion tons and \$1 trillion in the same year [2].

Historical reviews of the Suez Canal indicate that it has faced occasional disruptions over the past two decades, resulting in substantial global supply chain delays and costs. These incidents emphasize the canal's strategic importance and the need for robust operational resilience and safety measures [3]. Key terms that must be defined related to the analysis of these disruptions include risk, risk management, supply chain resilience, and sustainability. Risk, defined as the potential for events causing negative impacts on supply chain performance, necessitates comprehensive risk management, systematic identification, assessment, and mitigation of risks to ensure minimal operational disruption [10]. Supply chain resilience refers to the ability of supply chains to withstand, adapt, and quickly recover from disruptions, thereby ensuring continuity of material flow and business operations [11,12]. Sustainability encompasses long-term economic, environmental, and social viability, requiring supply chains to minimize environmental impact, maintain resource efficiency, and support economic growth [13].

Analysing risk management, resilience, and sustainability together, particularly concerning the Suez Canal disruptions, is crucial as these disruptions highlight systemic weaknesses in global supply chains. The Ever Given blockage and the 2023-2024 Red Sea geopolitical crisis reveal the interdependency of resilience and sustainability. The literature also raises concerns that resilient supply chains, capable of rapidly rerouting materials or utilizing strategic safety stocks, often conflict with sustainability goals, such as increased emissions from alternative routes or wasted materials from excessive inventory stocks. Organizations must find the correct balance between managing their long term sustainability goals and ensuring resilient and robust supply chains maintaining smooth production flow [13].

In prior decades the canal faced disruptions due to piracy threats in the late 2000s and political unrest during the Arab Spring in 2011 caused major risks for ships moving through the Red Sea and the canal, raising insurance costs and forcing some vessels to reroute to avoid high-risk areas [7]. One of the most notable disruptions in recent history was the Ever Given blockage in March 2021. Due to poor visibility from a sandstorm and technical issues, one of the world's largest container ships, about 400 meters long with a gross tonnage of 224,000, ran aground and fully blocked the canal [3]. This event had immediate, wide-reaching effects on global trade, creating serious delays for hundreds of ships waiting to transit. Supply chains were affected by increased shipping costs and late deliveries [4]. Tugboats, dredgers, and excavation equipment managed to refloat the vessel six days later, on March 29, 2021 [3,4]. The blockage's impact was immense, holding up an estimated \$9.6 billion worth of goods per day, totalling around \$57 billion throughout the event [3]. It also caused port congestion as delayed vessels arrived all at once, which was made worse by existing container shortages during the COVID-19 pandemic.

The shortage of empty containers in Asia required months to resolve due to rising transportation demands [14]. According to Reuters, global supply chains already strained by the pandemic and growing consumer demand faced even greater pressure, with about 10-15% of world container throughput affected. The six-day blockage highlighted what could happen if the canal ceases to operate in the global trade network. In 2024, the Red Sea crisis evolved into a major geopolitical conflict that severely affected global trade and maritime security. Attacks by Houthi insurgents on commercial vessels in the Red Sea disrupted international shipping and deeply affected global supply chains. With respect to 2024, the canal's utilization falls by 57% due to increased threat on the Red Sea [15]. India, depending heavily on the Red Sea route through the Suez Canal, as 50% of its exports and 30% of its imports travel this way, experienced significant shipping challenges and higher logistics costs already through 2024. Average shipment delays reached 21-28 days, potentially costing India more than \$30 billion in

exports as of the time of this research. Energy markets have also been highly vulnerable, with around 12% of worldwide oil trade moving through the Red Sea [2]. The conflict pushed oil prices above \$80 per barrel, prompting major oil and gas companies to suspend transits or reroute vessels. LNG shipments fell significantly as well since the crisis escalated [2,9]. The Ever Given blockage and the Red Sea crisis thus serve as crucial lessons for global shipping and organizations that rely on the canal, focalising the risks connected to Suez Canal transport [3].

Suez Canal disruptions have broad, worldwide effects beyond extra costs and scheduling delays. The blockages create significant problems in ports worldwide. Due to many ships arriving off-schedule, ports are facing significant congestions and increased handling times, further delaying vessels that are not directly affected by the canal closure but still arrive at the impacted ports [2]. An additional major outcome is ship and container shortages. When shipping times are increased and containers stay utilized for longer periods per shipment, their availability drops where they are most needed. This is true especially in Asia, where export demand remains high. These disruptions underscored serious weaknesses in the “just-in-time” supply chain model. As shipments were delayed, manufacturers lacked the materials they needed, which caused production slowdowns or stoppages [8,16]. The incident also raised environmental and safety worries. Rerouting around the Cape of Good Hope or increasing air freight leads to higher fuel use and carbon emissions. In addition, heavier traffic on alternative routes raises safety risks, particularly in areas prone to piracy or lacking the capacity to handle more maritime traffic [17].

Concerning lowering the risk of supply chain interruptions through the Suez Canal, the literature points to several approaches, focusing on agility, diversification, and technological progress. One main strategy is diversifying supply chain routes and sources: this way companies that do not rely solely on the canal reduce their exposure to major disruptions. This can also involve diversifying suppliers, so materials come from several regions rather than just one. Another tactic is revisiting safety stock strategies to improve resilience, which was prompted by the 2021 canal blockage. Many firms have decided to hold higher safety stocks or adopt a “just-in-case” inventory model for essential materials [17]. Technology and data analytics also offer ways to handle risks. Advanced tracking and monitoring systems provide real-time details on shipment locations and statuses, supporting proactive decisions and quicker responses. Predictive analytics can further estimate potential delays, allowing firms to modify their logistics plans [18]. Collaborative ties with suppliers, logistics providers, and other partners are also highlighted as a vital element in reducing risk. Flexible contracts and transparent communication help resources shift swiftly when disruptions happen [16].

Some organizations have adopted strategic stockpiling of key raw materials and finished goods to ease the effects of supply chain interruptions. This includes identifying which components are vital for production and holding them in storage. Nearshoring, which brings production closer to main markets, can reduce reliance on long-distance shipping routes like the Suez Canal and assist in minimizing disruption risks. Nearshoring and reshoring are increasingly common, particularly considering severe logistics disruptions that make complex supply chain operations less appealing. Financial tools such as cargo insurance and disruption insurance can help offset costs linked to events like the Suez Canal blockage [4,8].

The literature also notes a possible future shift from using the Suez Canal to traveling via the Northern Sea Route (NSR). Climate change has made the Arctic more and more navigable, but operating in that region requires unique ship specifications and involves uncertain travel times, ice conditions, and fuel costs. Even though the NSR is shorter between Europe and Asia, its overall economic competitiveness versus the Suez Canal is still a topic of debate. Moreover, increased use of the NSR may conflict with global sustainability goals due to further ice melting [19-21].

Organizations can also adopt smaller, simpler strategies to greatly cut the risk of supply chain disruptions. Building better, trust-based communication with partners ensures timely updates on possible delays [22]. This shared information lets companies adjust their operations and logistics plans promptly. Advanced tracking tools give real-time insight into shipments, making it possible to reroute shipments or alter schedules as needed [3,18]. Maintaining a flexible logistics approach allows for switching between different modes of transport or routes. For example, if a Suez Canal disruption is expected, firms can redirect cargo through alternative maritime paths or temporarily switch to air freight in the case of urgent items, though at a higher cost [8]. Partnering with multiple suppliers, especially those in various regions, further protects against raw material shortages [16]. Routine scenario planning exercises, including potential canal blockages, can help businesses respond more effectively when real disruptions occur, businesses can use pre-set action plans to reroute goods, reorganize production schedules, and communicate with key stakeholders [17].

When facing Suez Canal delays, organizations can take several steps to manage the impact on their supply chains and maintain production. First, they should quickly assess the scope of the disruption and its potential effects on supply chain operations. Analysing risks and costs helps prioritize actions. Next, organizations must clearly inform all parties involved, including suppliers, customers, and logistics providers, about expected effects, which supports collaborative problem-solving [22]. Having contingency plans ready allows firms to activate alternative sources of materials, shipping routes, or production schedules once they detect a delay [3,18]. Temporarily adjusting

production to focus on products with available materials might mean rearranging assembly lines or postponing items that are missing inputs [16]. Close collaboration with supply chain partners can also yield faster approvals, alternate suppliers, or logistic solutions to move shipments more rapidly [23]. Keeping customers informed and identifying top priorities during disruptions are essential. Constantly tracking the situation as it changes and gathering data on impacts can help guide decisions. Once the disruption subsides, a thorough review can reveal lessons and improvements to strengthen the given organization's future supply chain resilience [17].

This literature review provides essential context and theoretical grounding for understanding how organizations experience and manage disruptions to global logistics routes like the Suez Canal. It defines critical concepts such as risk, resilience, and sustainability, highlighting their interconnectedness during crises. This comprehensive review provides a baseline for the study's primary qualitative research, supporting the structuring of the topics discussed during interviews and analysis of real-world responses to disruptions and the development of actionable insights to strengthen organizational preparedness and response strategies.

### 3 Methodology

In order to explore raw material procurement processes during the Red Sea crisis at a specific multinational organization, the study used a case study methodology with an empirical, qualitative approach. This qualitative method allowed for a detailed examination of practical experiences, views, and strategic responses of logistics and supply chain experts within the studied company [24]. The approach aimed to identify adaptive strategies and practical solutions used by professionals in real-world scenarios, thus offering insights that benefit both theory and practice. Participants were selected through purposive sampling. The study focused on six raw material procurement planners from a European multinational production company that partly relies on moving raw materials from the Asia-Pacific region to Europe to guarantee smooth production flows. These individuals were selected based on their extensive experience, their critical role in logistics and procurement decisions, and their direct involvement in challenges related to Suez Canal disruptions [25].

Data collection combined two qualitative methods: individual semi-structured interviews and a group workshop. Each participant engaged in a detailed interview lasting 60 to 90 minutes. The interviews were guided by a pre-developed framework, complemented by open ended questions, which focused on three main thematic areas and allowed the interviewees to share their detailed experiences and thoughts:

- The impact of Suez Canal disruptions on raw material procurement from Asia and North America.
- Key lessons learned from previous disruptive events (e.g., Ever Given blockage, Red Sea conflict).

- Resilience strategies and contingency actions implemented to maintain material flow continuity.

Example questions included:

- "Can you describe how the Suez Canal disruptions affected your material sourcing timelines?"
- "What strategies, actions did your team adopt to mitigate the impact of these disruptions?"

The interviews allowed flexibility, enabling participants to share additional valuable insights based on their experiences with material and information logistics during crises. Following the interviews, a structured workshop involving all six participants was organized. The workshop was divided into three phases with the overall aim to allow participants to discuss their own practical takeaways from the crisis and to define common best practises:

- Reflection on individual experiences with recent Suez Canal disruptions.
- Group discussion on effective communication and human flow management during disruptions.
- Joint development of a defined action plan for enhancing future supply chain resilience.

The discussions were transcribed and thematically analysed using NVivo software. Thematic coding enabled the identification of patterns, categories, and emerging trends aligned with the study's research questions. To ensure validity and reliability, the findings and thematic interpretations were reviewed and confirmed with participants during a follow-up validation session. Participants provided consent before the research activities and were informed of their confidentiality rights and the study's adherence to ethical data protection principles.

### 4 Results

The thematic analysis of interviews and the workshop highlighted three major topics: communication, risk management, and sustainability. These were mapped systematically across the classical stages of risk management, risk factors, risk analysis and assessment, and proposals for reaction. This structure allows the empirical findings to reflect the material flow disruptions caused by the Suez Canal crises and the organizational responses aiming at maintaining resilient logistics operations.

#### Risk Factors

The procurement planners identified several key risk factors that disrupted material flow management during the Suez Canal blockage in 2021 and the Red Sea conflict of 2023 - 2024. The most significant risk factor and identified takeaway by the planners was the global ripple effect of localized events. Initially limited to shipments between Europe and Asia, the disruptions quickly extended to cargo flows between North America and Europe as container

availability and vessel scheduling were globally affected. Many local distributors underestimated the impact, believing the crisis was regionally contained, delaying organizational responses. Secondly, supply chain visibility limitations emerged as a critical risk. The planners indicated that suppliers often failed to monitor the arising risks and transport bottlenecks outside their immediate regions. Information logistics were insufficiently integrated, leading to delayed risk recognition and poor communication between partners. The interviewees reported that European distributors sourcing materials from North America did not anticipate for harbour congestions and delayed shipments, confirming placed orders with regular lead times. Thirdly, the organization's over-reliance on Asia-Pacific and North American suppliers without validated alternative sourcing options in Europe increased vulnerability. The organization was critically dependent on long, risk-prone maritime routes without backup options, intensifying delays once disruptions materialized. Lastly, environmental and sustainability-related trade-offs surfaced as latent risk factors. Measures like increasing air freight usage or building high safety stocks during disruptions clashed with the firm's long-term environmental targets, highlighting an operational dilemma between resilience and sustainability.

### **Risk Analysis and Assessment**

The analysis revealed significant organizational gaps in early warning systems and scenario planning for globally cascading events. During the 2021 Suez Canal blockage, planners handling Asian portfolios received disruption alerts earlier than those handling North American suppliers. The absence of unified material flow monitoring across all regions delayed the organization's understanding of the crisis's global magnitude, causing loss of critical response time. The workshop participants emphasized that information asymmetry within the supply chain, the lack of real-time shipment visibility and delayed supplier updates, halted quick decision-making. Some suppliers continued to confirm standard delivery times despite clear logistical bottlenecks, creating a false sense of material availability. Through thematic coding, insufficiently diversified transportation routes was another serious risk that was identified. Heavy dependency on the Suez Canal for material flows without pre-approved alternative suppliers left the supply chain vulnerable. The firm's safety stock policies were also critically assessed. Prior to the crises, stock levels were optimized mostly for lean operations, minimizing holding costs but offering little protection against such critical transportation delays. When shipment lead times expanded by several weeks, production flows were shortly also interrupted. Planners further reflected on the conflict between emergency measures and sustainability goals. Rushed adaptations, like switching to air freight, helped recover raw material availability in the short term but significantly increased carbon emissions and

operational costs, revealing the hidden costs of resilience under pressure.

### **Proposals for Reaction**

One core proposal resulting from the interviews and workshop was the implementation and standardization of continuous scenario planning. The organization must regularly assess economic risks and simulate possible regional and global crises affecting material flows, integrating variables like port congestion, vessel capacity fluctuations, and regional conflicts. Advanced information logistics systems were recommended, enabling real-time monitoring of transport bottlenecks, supplier performance, and lead times. The organization must realize in time that local disruptions can easily cascade into global threats, alerting all stakeholders accordingly.

The workshop stressed the importance of trust-based partnerships with suppliers and logistics service providers. Trust enhances the willingness of partners to share early warnings and to prioritize urgent shipments. The organization plans to formally request from strategic suppliers the establishment of shared risk monitoring protocols, including the regular exchange of critical updates on potential disruptions. Suppliers will be expected to map their own upstream vulnerabilities and inform buyers accordingly. The organization also plans to improve its collaboration efforts. In case the organization defines critical risks, affected suppliers will be notified accordingly, ensuring that vendors are also alarmed, with the expectation towards them to find mitigating solutions in time. Internally, the planners recommended strengthening cross-functional communication between procurement, production, sales, and finished goods logistics. Weekly updates in times of crisis on global supply chain status and pending risks should be standardized, ensuring that material flow disruptions are addressed collaboratively across departments.

The interviews revealed a consensus that greater supply chain redundancy is necessary. This includes validating secondary, regional suppliers in Europe for critical raw materials. Although costlier, dual sourcing would ensure that alternative material flows can be activated rapidly when major maritime routes like the Suez Canal are disrupted. Higher safety stock levels for critical materials were also proposed, particularly for products which transportation relies heavily on high-risk routes. The organization recognized that short-term resilience measures, such as increased air freight and emergency stockpiling, often conflict with its long-term sustainability goals. To balance these demands, it is pursuing local sourcing to reduce carbon emissions while strengthening material flow continuity. By fostering closer cooperation and trust with suppliers on green logistics initiatives, the company seeks to integrate environmental responsibility into its resilience planning. In the long term, aligning sustainability with supply chain flexibility enhances brand reputation, supports customer expectations, and builds a

more competitive, future-proof logistics network capable of withstanding global disruptions.

## 5 Discussion

This section integrates insights from the literature review on the Suez Canal's disruptions and its global importance with the findings from interviews and a workshop involving raw material planners.

The already available literature showed that the Suez Canal has played a key role in connecting Europe, the Middle East, and Asia since its opening in 1869 [1,5]. Its ability to shorten the distance between ports in the Asia-Pacific region and Europe leads to significant savings in both cost and time [2,4,16,22]. However, its importance also makes it highly vulnerable to disruptions. Events such as the Red Sea crisis, which started in 2023, show that even a local crisis can trigger widespread consequences [2,3]. According to Galil et al. (2017) and Khan and Rahman (2021), rerouting vessels around the Cape of Good Hope or switching to air freight is expensive, taxes the environment, and is complex logistically [4,7]. The organization's planners confirm the canal's central role in maritime trade. During both the 2021 blockage and the 2023-2024 Red Sea crisis, once the canal or its adjacent routes were compromised, raw material supplies were severely affected. This aligns with the literature suggesting that disruptions to such a critical waterway can have global effects [8].

A major theme from both the literature and the Interviews is how easily a regional crisis can become a global problem. The Suez Canal disruptions created chain reactions in shipping schedules causing port congestion and shortages of ships and containers [2]. This pattern also affected the studied organization. Many suppliers and regional distributors did not realize the scale of the disruption until shipments were already delayed. Some assumed the crisis was confined to Europe-Asia routes only to discover that shipments from North America were also delayed by port congestion and missing vessels. In line with prior findings, the company's planners noted that distributors and suppliers were slow to communicate possible delays, which revealing a lack of awareness and proactive planning. Similar to what Galil et al. (2017) and Rusinov et al. (2021) observe, companies relying on just-in-time deliveries were particularly vulnerable. Although North American shipments initially appeared safe from the Red Sea crisis, they were eventually stuck or delayed as shipping lines struggled to manage capacity worldwide [3,7,16]. As global supply chains become more interconnected, disruptions in one region can affect the availability of ships, container positioning, and transit times worldwide. The organization now plans to broaden its risk management framework to consider not just local or regional threats but also how quickly these can escalate globally. This strategy follows those recommendations in the literature that call for continuous monitoring and scenario planning for essential chokepoints [18,19].

Building on academic risk management models [18,21], the firm's new focus on real-time tracking and scenario-based simulations aims to close awareness gaps, potentially reducing reliance on costly, high-emission emergency measures.

The interviews also revealed that the organization has changed its approach to inventory management. Related research underscores the value of safety stocks for protection against sudden delays [9]. Maintaining extra inventory ties up capital and may increase the risk of scrapping unused materials, but planners agreed that buffers are necessary for critical items. During the early stages of the Red Sea crisis, the organization lacked sufficient safety stock to cover prolonged delays, which put production at risk and forced the company to use of high-cost air freight. The firm now plans to identify which materials truly require higher inventory based on their criticality and fluctuating lead times.

Another key insight from the interviews is the organization's dependence on Asian and North American suppliers under normal conditions, which leaves few alternatives when maritime disruptions hit. The literature recommends diversifying suppliers geographically to avoid overreliance on one region or shipping route [8,17]. Interviewees described how the company is now validating regional suppliers, even though these are more expensive. By having contracted local suppliers for smaller volumes, the organization retains flexibility and can scale up domestic orders if a major blockage or conflict disrupts global routes. This finding supports earlier work suggesting that nearshoring or "multi-shoring" helps firms balance cost effectiveness with resilience [23].

Workshop discussions also confirmed that many suppliers and distributors failed to recognize the global scope of the Suez Canal disruptions until it was too late. The literature stresses the importance of transparent, timely communication in crises [17]. The organization's experience demonstrates the ways even small delays can escalate when communication is poor. Some distributors continued confirming shipping dates based on standard schedules, which created a misleading sense of security. To fix this, the company is committed to building stronger, trust-based relationships with suppliers. It will share disruption warnings more promptly and expects suppliers to respond in ways that reduce potential negative outcomes [3]. Internally, the workshop highlighted the need for better coordination between procurement, sales, production, and distribution teams. During the Suez Canal incident, not all departments were informed concurrently, which caused confusion and inconsistent messaging to customers. The updated strategy involves frequent cross-department briefings ensuring that everyone can make faster decisions and minimize duplicated efforts or missed opportunities to reroute shipments [21]. Many customers were also more understanding when they were offered early warnings about potential delays, which allowed their firms to allocate resources to fulfil their most critical orders first.

When critical shortages and production line shutdowns occurred, the organization had to quickly switch to faster transport options like air freight to maintain raw material flow. However, a central topic at the workshop was the conflict between resilience-building and environmental objectives. The literature notes that rerouting ships around Africa or relying on air freight both increase carbon emissions [3]. The company's interviews confirmed that while air freight kept production running when vessels were delayed, it undermined the firm's long-term environmental goals. Likewise, holding larger safety stocks can result in more waste if demand changes or materials expire [3]. Local sourcing emerged from both the literature and the workshop as a potential compromise. By validating suppliers closer to production sites, the organization reduces transit times, cuts shipping emissions, and lowers the chance of major disruptions at chokepoints. Studies by Schøyen and Bråthen (2011) and Dui et al. (2023) indicate that nearshoring reduces ecological impact compared to long-distance shipping. However, local suppliers can be much more expensive, forcing the organization to strike a balance between resilience and sustainability [18,21].

The literature also points out that less sustainable packaging can be cheaper and more reliable, yet this conflicts with many firms' recycling or sustainability goals. Recyclable or biodegradable packaging can cost more, may be less sturdy, and is often limited in availability [13]. Overall, the interviewed planners agreed that complete alignment between resilience and sustainability is challenging, especially during emergencies. They do believe, though, that enhanced planning and long-term risk management can help reduce environmental harm [2,3]. When disruptions are identified early and are correctly evaluated, the organization is more likely to adopt solutions that support both uninterrupted operations and environmental objectives [3].

From a broader perspective, these findings demonstrate that the Suez Canal disruption should be seen not as an isolated crisis, but as a model of how quickly severe issues can arise in vital supply chains. The lessons gained here aim to help firms handle major disruptions more effectively [22]. Overall, the results confirm and enhance existing literature on building supply chain resilience, emphasize diversification, proactive communication and flexible contingency planning [7,9]. The experiences gathered through the interviews offer practical insights to aid bridging the gap between theory and real-world practice. By combining academic perspectives with practical experiences, this discussion highlights that supply chain resilience is an evolving process rather than a fixed goal. With continuous learning and adaptation, organizations can better sustain production and will be able to respect their long-term environmental commitments.

## 6 Conclusions

The research problem in this study focuses on how disruptions in the Suez Canal affect global supply chains and the strategies organizations use to become more resilient against such risks. This topic is crucial as the Suez Canal plays a major role in global trade, and any disruption can significantly impact international logistics and commerce [2]. The canal's ability to shorten delivery times and reduce transportation costs highlights its importance in keeping supply chains efficient and reliable [3]. This study used a qualitative research design that included semi-structured interviews and a group workshop with raw material planners from a multinational production firm. This approach provided detailed, practical information about how these planners managed actual supply chain disruptions, which offered an in-depth look at the strategies used by those directly affected by Suez Canal disruptions. The data was thematically coded using Nvivo software, which helped organize and analyse the key themes and patterns emerging from the participants' comments.

The literature review emphasized the canal's historical significance and its vulnerabilities, showing the need for strong risk management and communication to reduce the impact of disruptions [3,7]. The 2021 Ever-Given incident and the 2024 Red Sea conflict illustrated how these disruptions can affect global trade and logistics. The research demonstrated that early risk identification, proactive scenario planning, and steady communication are critical for supply chain resilience. Findings confirmed that seemingly local disruptions can rapidly escalate globally and significantly hinder production if underestimated. Building trust-based supplier relationships, diversifying sourcing routes, and integrating sustainability into resilience strategies emerged as key actions. The study emphasizes that continuous information logistics, risk management, and regional supply base development are essential to mitigating future crises, balancing operational continuity with long-term environmental goals.

Limitations of the research include its case study methodology, which focuses only on one production organization, which may limit the variety of perspectives. As a result, the findings might not be fully applicable to organizations of different sizes, scopes, or operational settings. Second, the lack of audio or video recordings means that non-verbal cues were not captured, which potentially caused a loss of additional insights. However, the study offers a detailed exploration of how Suez Canal disruptions affect supply chain management, featuring real-world examples of strategies that increase resilience. These insights are valuable for organizations looking to strengthen their supply chains against future disruptions, especially given the limited amount of available practical knowledge of this topic.

Future research could include more participants from various organizations and industries affected by Suez Canal disruptions. This broader approach would strengthen

the applicability of the findings and give a more comprehensive view of the challenges and strategies involved in managing supply chain disruptions. Also, combining qualitative insights with quantitative data could help confirm the study's results and expand how the findings can be used. For example, quantitative measures could assess the financial costs of supply chain disruptions, measure how effective different resilience strategies are, and consider the trade-offs between resilience and sustainability with reference to decisions impacting supply chains.

## References

- [1] FLETCHER, M.E.: The Suez Canal and world shipping, 1869-1914, *The Journal of Economic History*, Vol. 18, No. 4, pp. 556-573, 1958. <https://doi.org/10.1017/S0022050700107740>
- [2] WAN, Z., SU, Y., LI, Z., ZHANG, X., ZHANG, Q., CHEN, J.: Analysis of the impact of Suez Canal blockage on the global shipping network, *Ocean and Coastal Management*, Vol. 245, 106868, 2023. <https://doi.org/10.1016/j.ocecoaman.2023.106868>
- [3] FAN, S., YANG, Z., WANG, J., MARSLAND, J.: Shipping accident analysis in restricted waters: Lesson from the Suez Canal blockage in 2021, *Ocean Engineering*, Vol. 266, pp. 1-13, 2022. <https://doi.org/10.1016/j.oceaneng.2022.113119>
- [4] KHAN, A., RAHMAN, S.: Review and analysis of blockage of Suez Canal region due to giant container ship, *Marine Technology Society Journal*, Vol. 55, No. 5, pp. 39-43, 2021. <https://doi.org/10.4031/MTSJ.55.5.5>
- [5] POR, F.D.: One hundred years of Suez Canal—a century of Lessepsian migration: retrospect and viewpoints, *Systematic Zoology*, Vol. 20, No. 2, pp. 138-159, 1971. <https://doi.org/10.2307/2412054>
- [6] SAITO, T., SHIBASAKI, R., MURAKAMI, S., TSUBOTA, K., MATSUDA, T.: Global maritime container shipping networks 1969-1981: Emergence of container shipping and reopening of the Suez Canal, *Journal of Marine Science and Engineering*, Vol. 10, No. 5, 602, pp. 12-20, 2022. <https://doi.org/10.3390/jmse10050602>
- [7] GALIL, B., MARCHINI, A., OCCHIPINTI-AMBROGI, A., OJAVEER, H.: The enlargement of the Suez Canal – Erythraean introductions and management challenges, *Management of Biological Invasions*, Vol. 8, No. 2, pp. 141-152, 2017. <https://doi.org/10.3391/mbi.2017.8.2.02>
- [8] SHIBASAKI, R., YOSHIDA, T., AZUMA, T.: Route choice of containership on a global scale and model development: Focusing on the Suez Canal, *International Journal of Transport Economics*, Vol. 43, No. 3, pp. 265-290, 2016.
- [9] MEZA, A., ARI, I., SADA, M.A., KOÇ, M.: Disruption of maritime trade chokepoints and the global LNG trade: an agent-based modeling approach, *Maritime Transport Research*, Vol. 3, pp. 1-25, 2022. <https://doi.org/10.1016/j.martra.2022.100071>
- [10] XU, S., ZHANG, X., FENG, L., YANG, W.: Disruption risks in supply chain management: a literature review based on bibliometric analysis, *International Journal of Production Research*, Vol. 58, No. 11, pp. 3508-3526, 2020. <https://doi.org/10.1080/00207543.2020.1717011>
- [11] CHOWDHURY, M.M.H., QUADDUS, M.: Supply chain resilience: Conceptualization and scale development using dynamic capability theory, *International Journal of Production Economics*, Vol. 188, pp. 185-204, 2017. <https://doi.org/10.1016/j.ijpe.2017.03.020>
- [12] IVANOV, D.: Revealing interfaces of supply chain resilience and sustainability: a simulation study, *International Journal of Production Research*, Vol. 56, No. 10, pp. 3507-3523, 2018. <https://doi.org/10.1080/00207543.2017.1343507>
- [13] RAJESH, R.: On sustainability, resilience, and the sustainable-resilient supply networks, *Sustainable Production and Consumption*, Vol. 15, pp. 74-88, 2018. <https://doi.org/10.1016/j.spc.2018.05.005>
- [14] GONEN, E.: China and the Suez Canal—Politics, Economy, and Logistics, In: Lutmar, C., Rubinovitz, Z. (eds) *The Suez Canal: Past Lessons and Future Challenges*. Palgrave Studies in Maritime Politics and Security. Palgrave Macmillan, Cham., pp. 27-41, 2023. [https://doi.org/10.1007/978-3-031-15670-0\\_2](https://doi.org/10.1007/978-3-031-15670-0_2)
- [15] NOTTEBOOM, T., HARALAMBIDES, H., CULLINANE, K.: The Red Sea Crisis: ramifications for vessel operations, shipping networks, and maritime supply chains, *Maritime Economics & Logistics*, Vol. 26, No. 1, pp. 1-20, 2024. <https://doi.org/10.1057/s41278-024-00287-z>
- [16] RUSINOV, I., GAVRILOVA, I., SERGEEV, M.: Features of Sea Freight through the Suez Canal, *Transportation Research Procedia*, Vol. 54, pp. 719-725, 2021. <https://doi.org/10.1016/j.trpro.2021.02.125>
- [17] MALKUS, T., TYRANSKA, M.: Reaction to risk in logistics cooperation-Results of empirical research, *Acta logistica*, Vol. 6, No. 3, pp. 77-84, 2019. <https://doi.org/10.22306/al.v6i3.124>
- [18] DUI, H., LIU, K.X., WU, S.M.: Data-driven reliability and resilience measure of transportation systems considering disaster levels, *Annals of Operations Research*, Vol. 340, pp. 217-243, 2024. <https://doi.org/10.1007/s10479-023-05301-w>
- [19] VERNY, J., GRIGENTIN, C.: Container shipping on the Northern Sea Route, *International Journal of Production Economics*, Vol. 122, No. 1, pp. 107-117, 2009. <https://doi.org/10.1016/j.ijpe.2009.03.018>
- [20] SCHØYEN, H., BRÅTHEN, S.: The Northern Sea Route versus the Suez Canal: cases from bulk shipping, *Journal of Transport Geography*, Vol. 19, No. 4, pp. 977-983, 2011.

- <https://doi.org/10.1016/j.jtrangeo.2011.03.003>
- [21] PHILIPPART, C.J.M., ANADÓN, R., DANOVARO, R., DIPPNER, J.W., DRINKWATER, K.F., HAWKINS, S.J., OGUZ, T., O'SULLIVAN, G., REID, P.C.: Impacts of climate change on European marine ecosystems: Observations, expectations and indicators, *Journal of Experimental Marine Biology and Ecology*, Vol. 400, No. 1-2, pp. 52-69, 2011.  
<https://doi.org/10.1016/j.jembe.2011.02.023>
- [22] MOSTAFA, M.M.: Forecasting the Suez Canal traffic: a neural network analysis, *Maritime Policy & Management*, Vol. 31, No. 2, pp. 139-156, 2004.  
<https://doi.org/10.1080/0308883032000174463>
- [23] FERNÁNDEZ-MIGUEL, A., RICCARDI, M.P., VEGLIO, V., GARCÍA-MUÑA, F.E., FERNÁNDEZ DEL HOYO, A.P., SETTEMBRE-BLUNDO, D.: Disruption in Resource-Intensive Supply Chains: Reshoring and Nearshoring as Strategies to Enable Them to Become More Resilient and Sustainable, *Sustainability*, Vol. 14, No. 17, pp. 1-13, 2022. <https://doi.org/10.3390/su141710909>
- [24] YIN, R.K.: *Case Study Research and Applications*, 6<sup>th</sup> ed., Sage Thousand Oaks, CA, 2018.
- [25] SAUNDERS, M., LEWIS, P., THORNHILL, A.: *Research Methods for Business Students*, 8<sup>th</sup> ed., Pearson education, 2019.

**Review process**

Single-blind peer review process.