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Advancing Sustainable Logistics Resilience: Risk Management Strategies for Global Uncertainties and Climate Challenges

FRANCK MBA DEFFO[1]

[1] *College of Business and Technology, Wilmington University, Delaware, U.S.A*

RÉSUMÉ

Les réseaux logistiques mondiaux, qui gèrent plus de 90 % du commerce international et contribuent à environ 21 % des émissions mondiales de carbone (Ly, 2023 ; Brand, 2021), subissent une pression croissante provenant de deux sources principales : des enjeux géopolitiques tels que les droits de douane, les guerres commerciales et les perturbations en mer Rouge (Marsh, 2026), ainsi que des défis liés au climat, notamment les phénomènes météorologiques extrêmes, les sécheresses et les inondations qui affectent les ports et les routes commerciales (Economist Impact, 2025). Les stratégies « lean », conçues principalement pour l'efficacité plutôt que pour la résilience face aux chocs, tendent à aggraver cette vulnérabilité. De nouvelles exigences en matière de durabilité, telles que le Pacte vert européen (EU Green Deal) et les objectifs de décarbonation de l'OMI, appellent désormais à intégrer la gestion des risques au sein de ces réseaux afin de renforcer leur résilience à long terme (Chen et al., 2025).

Cet article conceptuel synthétise la littérature récente afin d'identifier les incertitudes clés inhérentes aux opérations logistiques ainsi que leurs impacts, et passe en revue les stratégies éprouvées de gestion des risques permettant de les atténuer. Les implications pratiques pour les responsables logistiques et les décideurs politiques sont exposées.

Mots-clés *: Gestion des risques, incertitude géopolitique, risque climatique, logistique durable, résilience de la chaîne d'approvisionnement.*

ABSTRACT

Global logistics networks, which handle over 90% of international trade and contribute around 21% of global carbon emissions (Ly, 2023; Brand, 2021), are under increasing pressure from two main sources: geopolitical issues like tariffs, trade wars, and Red Sea disruptions (Marsh, 2026), and climate-related challenges including extreme weather, droughts, and floods that affect ports and routes (Economist Impact, 2025). Lean strategies, designed primarily for

* Auteur correspondant. Courriel : fmbadeffo001@my.wilmu.edu

efficiency rather than resilience to shocks, tend to exacerbate this vulnerability. New sustainability requirements, such as the EU Green Deal and IMO decarbonization goals, now call for integrating risk management into these networks to enhance long-term resilience (Chen et al., 2025).

This conceptual paper synthesizes recent literature to identify key uncertainties in logistics operations, their impacts, and reviews proven risk management strategies to mitigate them. Practical implications for logistics managers and policymakers are outlined.

***Keywords**: Risk management, geopolitical uncertainty, climate risk, sustainable logistics, supply chain resilience.*

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INTRODUCTION

The global logistics sector stands at a critical inflection point. In 2025–2026, persistent Red Sea rerouting (Nastali, 2026), Strait of Hormuz blockage (Mandra, 2026), escalating US/EU tariffs (Corlin & Genovese, 2026), and climate-induced disruptions (Marsh, 2026) have exposed the fragility of supply chain just-in-time models. These events compound with regulatory pressures for decarbonization and environmental, social, and governance (ESG) compliance, creating dual physical (extreme weather) and transitional (carbon pricing, supply-chain due diligence) risks.

Sustainable logistics that integrate environmental, economic, and social factors into operations (transportation, warehousing, last-mile, and reverse flows) to enhance long-term objectives (Ibrahim et al., 2024) must now incorporate resilience as a core capability. Risk management serves as the integrative bridge between its main function of identifying, assessing, mitigating, and adapting to uncertainties (Gibson, 2023) while advancing low-carbon, circular operations.

Recent systematic analyses confirm rapid evolution in logistics, with frameworks increasingly linking sustainability, resilience, and digitalization during the industry 4.0-to-5.0 transition (Zaoui et al., 2026). Yet logistics-specific strategies for simultaneous climate and geopolitical challenges remain fragmented. This paper addresses that gap by reviewing existing literature on logistics resilience, mapping key uncertainties, cataloging, and proposing risk management strategies.

This narrative review sources literature via structured keyword searches combining terms like "supply chain resilience," "risk management," "sustainable logistics," "triple bottom line," "dynamic capabilities," "geopolitical risk," "climate risk logistics," and "maritime chokepoint disruption," mainly from Scopus, Web of Science, ScienceDirect, and Google Scholar. It also includes targeted searches of intergovernmental and policy sources (e.g., UNCTAD, C2ES, CSIS) for recent developments not in peer-reviewed outlets. Sources are verified with Scite to confirm bibliographic accuracy and citation support. Peer-reviewed articles form the core, with foundational work included without date limits (e.g., Elkington, 1998), and recent empirical literature from 2020–2026. Grey literature (industry reports, trade press, news) from 2021–2026 illustrates specific, recent events like tariff policy shifts, chokepoint disruptions, and regulatory deadlines, not yet covered by academic literature, aligning with this paper's conceptual focus. Sources were retained if directly relevant to logistics or supply chain resilience, risk management, or sustainability, and excluded if non-English, unverifiable, or lacking institutional or editorial oversight.

I. CONCEPTUAL FOUNDATIONS

The integration of sustainable logistics, resilience, and risk management requires a clear conceptual foundation to address the multifaceted uncertainties of 2025–2026, including geopolitical volatility, climate extremes, and regulatory transitions. This section defines the core concepts, explores their interrelationships, and draws on established theories to frame the subsequent discussion of uncertainties and strategies.

I.1. Sustainable logistics

Sustainable logistics extends traditional green logistics by adopting the triple bottom line (TBL) framework (Elkington, 1998), which balances economic prosperity, social equity, and environmental stewardship (people, planet, profit). First coined by John Elkington in 1994, TBL posits that organizational success should be measured not solely by financial performance but by equal contributions to social well-being, environmental health, and a fair economy.

In logistics contexts, this translates to:

- The environmental pillar that encompasses:
  - Decarbonization initiatives such as the reduction of Scope 3 emissions through route optimization and the adoption of low-carbon fuels.
  - Circularity, which includes reverse logistics, remanufacturing, and waste minimization initiatives.
  - Resource efficiency, which involves deploying electric fleets and implementing sustainable packaging solutions.
- The social pillar, which pertains to ethical labor practices, fair wages, community impact, equity in supply networks, and worker safety amid automation.
- The economic pillar that encompasses operational efficiency, cost competitiveness, and long-term viability without compromising the other pillars.

Recent applications emphasize TBL as a regenerative framework for logistics, enabling organizations to evolve toward sustainable systems while meeting regulatory demands and stakeholder expectations (Ferrer-Serrano & Salesa, 2025).

I.2. Resilience in logistics

Cheng and Shan (2025) and Scholten and Schilder (2015) note that supply chain resilience refers to a logistics network's ability to anticipate, absorb, adapt to, and recover from disruptions while maintaining continuity and performance. They also highlight four core pillars in resilient supply chains:

- Visibility: also referred to as real-time end-to-end transparency, is essential for the identification and resolution of potential disruptions.
- Flexibility: enables businesses to promptly modify their supply chain operations to accommodate the unexpected.
- Contingency: entails establishing backup procedures and maintaining additional inventory to ensure business continuity during periods of disruption.
- Collaboration: promotes strong relationships between internal teams and external partners, which are vital for effective supply chain management.

Resilient logistics goes beyond recovery to proactive adaptation in volatile environments (e.g., pandemics, extreme weather, tariffs). It emphasizes balancing preparedness with responsiveness, enabling networks to withstand shocks and emerge stronger. In sustainable contexts, resilience incorporates TBL outcomes, ensuring disruptions do not undermine environmental or social goals.

I.3. Key global uncertainties and climate risks impacting sustainable logistics

Sustainable logistics networks encompassing ocean freight, inland transport, warehousing, last-mile delivery, and reverse flows are increasingly vulnerable to intertwined geopolitical/economic and climate-related uncertainties. In 2025–2026, these have manifested as prolonged disruptions at critical chokepoints (Red Sea/Suez, Strait of Hormuz, Panama Canal), tariff-driven trade fragmentation, and escalating physical/transitional climate risks. The World Bank's Global Supply Chain Stress Index - Maritime (GSCSI-M), presented by Arvis et al. (2026) and (UN Trade and

Development [UNCTAD], 2024), highlights that such events cause widespread delays, rerouting, and higher emissions, with annual economic losses estimated in billions of U.S dollars.

I.3.1. Geopolitical and economic uncertainties

Geopolitical tensions and policy shifts have reshaped global trade routes and costs, amplifying concentration risks in key shipping lanes and raw materials. These developments have not only increased operational complexity for logistics providers but also triggered widespread supply chain reconfiguration and elevated risk exposure across multiple transport modes. Among the prominent manifestations in 2025-2026 are the following:

- Tariff escalations and trade fragmentation

The United States-led tariff policies in 2025-2026, including a temporary global import surcharge of up to 15% imposed under Section 122 of the Trade Act of 1974 (following a U.S. Supreme Court ruling that invalidated prior levies under the International Emergency Economic Powers Act), have significantly disrupted global trade patterns.

These policies have accelerated trade reshuffles and supply chain realignments, with estimates indicating that tariff escalations in 2025 alone redirected or reshuffled more than $400 billion in global trade flows (Orlando, 2026) as companies adjusted sourcing to mitigate costs and risks. This fragmentation has disrupted traditional container flows, particularly on Asia-Europe/US routes, while accelerating nearshoring (relocating production closer to end markets) and friend-shoring (shifting to politically aligned partners). Logistics operators reliant on established long-haul routes face higher freight rates, extended transit times, increased insurance premiums, and greater operational complexity due to these shifts.

- Maritime chokepoints volatility

After over two years of nearly avoiding the Red Sea route due to Houthi attacks (Blair, 2024), early 2026 saw some major carriers cautiously return. For example, the Gemini Cooperation (Maersk and Hapag-Lloyd) announced that it would resume select services through the Red Sea and the Suez Canal from mid-February 2026. Ships like Albert Maersk (westbound) and Astrid Maersk (eastbound) transited with naval escort for security (Hennessey, 2026). This marked a milestone, testing the corridor on routes like ME11 (India/Middle East to Mediterranean), with successful voyages in late 2025/early 2026.

From late 2022 to 2024, a severe drought across the Panama Canal reduced transit volumes, leading to vessel weight restrictions to conserve water (LaRocco, 2025). After investments to address drought risks, the canal experienced a 19.3% increase in FY2025, with 13,404 transits compared to 11,240 in FY2024 when drought affected operations (Labrut, 2025).

While water recovery eased capacity issues, strategic concerns over the canal's control remain. US-China tensions have drawn attention to Chinese port operations at Balboa and Cristobal, run by CK Hutchison (Berg et al., 2025), raising neutrality questions under the US-Panama Neutrality Treaty.

Globally, maritime chokepoints face hazards such as piracy, conflict, climate extremes, terrorism, and accidents (Verschuur et al., 2025). A study of 24 major choke points, including the Suez Canal, the Bab el-Mandeb Strait, and the Strait of Malacca, shows that disruptions cause roughly $10.7 billion in annual economic losses, about 0.04% of global trade (Yarwood, 2026).

I.3.2. Climate-related risks

Climate risks include physical risks (weather and environmental impacts) and transitional risks (policy and market shifts to low-carbon economies). These pose uncertainties and financial threats to firms, industries, and infrastructure, becoming "threat multipliers" in geopolitical and economic disruptions (Frank & Radulovic, 2025).

- Physical risks

Physical risks manifest in two forms: acute (sudden high-intensity events) and chronic (gradual, persistent changes).

- Acute events, such as floods, hurricanes/typhoons, heatwaves, storms, disrupt logistics infrastructure. For example, multiple hurricanes in 2024 caused port closures along the US Gulf Coast, stopping vessel traffic (Neuffer, 2024). Heatwaves also affect rail tracks; 1800 feet of rail can grow over an inch for every 10°F rise (Simon, 2024).
- Chronic conditions such as climate change cause gradual shifts in the ocean's physics and chemistry, including acidification, warming, sea ice loss, and sea level rise (SLR). SLR and extreme sea-level events are among the top climate concerns globally (Magnan et al., 2022). Warming oceans disrupt trade routes, lower cargo efficiency, and increase stress on refrigerated supply chains.

- Transitional risks

Transitional risks stem from the transition to a low-carbon economy, primarily through regulatory mandates and market mechanisms.

One example is the introduction of the Carbon Border Adjustment Mechanism (CBAM). Under this system, importers of carbon-intensive goods such as steel, aluminum, cement, fertilizers, electricity, and hydrogen must report the embedded emissions in their imports and surrender CBAM certificates matching those emissions. The European Commission is considering expanding CBAM beyond primary materials to include downstream goods, such as machinery and manufactured products that contain steel or aluminum inputs. Such an expansion would increase compliance requirements across global supply chains and add to the administrative burden for manufacturers and importers (Graham, 2026).

Global shipping is also facing increasing regulatory pressure under the International Maritime Organization's (IMO) climate strategy. The 2023 IMO Strategy sets out a plan for the maritime sector to reach net-zero greenhouse gas emissions, with interim milestones including reducing total annual emissions from international shipping by at least 20% (aiming for 30%) by 2030 and by at least 70% (aiming for 80%) by 2040 compared to 2008.

I.3.3. Logistics-specific impacts

Geopolitical and economic uncertainty, as well as climate-related risks, negatively influence routing decisions, operational efficiency, infrastructure reliability, and transportation cost (Wu, 2026; Sun et al., 2026). Because logistics systems rely on tightly coordinated global infrastructure, disruptions in one segment identified above can propagate across the entire supply chain.

- Route volatility and emissions inflation

As detailed in I.3.1, chokepoint disruptions at the Panama Canal, Suez, and Red Sea force vessels onto longer routes such as the Cape of Good Hope detour (Wu, 2026), with direct cost and emissions consequences here: longer transit times raise transportation and Scope 3 emissions, and disrupt port scheduling, warehousing capacity planning, and last-mile distribution systems. The Gulf conflict discussed in I.3.1 compounds this: Krischik and Kester (2026) report a surge in insurance rates for Gulf ships, increasing from $250,000 to $375,000 for a $100 million vessel.

Supply chain managers may respond by increasing safety stock or using expedited transportation methods, both of which can raise operational costs and emissions intensity across logistics networks.

- Infrastructure damage and operational halts

Logistics infrastructure is highly vulnerable to extreme weather events. Floods, hurricanes, and heatwaves can temporarily shut down ports, damage transport routes, and delay cargo flows. For example, coastal ports such as the Port of Houston and Port of New Orleans periodically suspend operations during severe storms, disrupting vessel schedules and freight handling (Neuffer, 2024). These disruptions cause cascading delays across global supply chains and increase congestion in alternative transport routes. In addition to sudden events, long-term climate conditions can gradually weaken infrastructure performance. Rising temperatures can warp rail tracks and damage road surfaces, while sea-level rise threatens coastal terminals through flooding and saltwater intrusion (Simon, 2024). These changes raise maintenance costs, operational downtime, and the risk of cargo losses. Priestman (2026) reports that new research from DP World shows that recurring breakdowns across global supply chains are directly leading to lost productive time, higher costs, and ongoing pressure on growth and competitiveness.

- Reverse and circular logistics costs

Designed to support circular economy practices such as product returns, repair, recycling, and remanufacturing (Mallick et al., 2023), reverse logistics systems are also impacted by economic uncertainties and climate-risk disruptions. These logistics processes depend on stable transport networks and predictable collection flows. When disruptions occur, firms face increased costs in transporting returned goods, managing storage capacity, and coordinating recovery processes (Sonar et al., 2024).

II. RISK MANAGEMENT STRATEGIES FOR ADVANCING RESILIENCE

Once uncertainties and risks within the logistics network are identified, it becomes crucial to develop a risk management strategy or mitigation plan to help organizations navigate these challenges effectively. First, what is the concept of risk management? Pournader et al. (2020) define supply chain risk broadly as the chance of danger, damage, loss, or other undesired consequences arising from disruptions to supply chain operations. Various factors, including economic, technological, environmental, and competitive elements, create challenges that organizations must proactively address and mitigate (Gibson, 2023). Risk management is thus a systematic process that involves identifying, assessing, and mitigating threats or uncertainties that could affect the organization (Gibson, 2023; Pournader et al., 2020). It includes analyzing the probability and potential impact of risks, devising strategies to minimize harm, and continuously monitoring the effectiveness of these measures.

Table 1 proposes a risk management strategy to mitigate global uncertainty and climate challenges. The first column indicates the type of uncertainty, followed by the second column, which itemizes the key tactics that may be employed to navigate it effectively. The third column links each set of strategies to the specific resilience pillars introduced in Section I.2 (visibility, flexibility, contingency, and collaboration), making explicit which capability each tactic strengthens. The fourth column presents the resilience benefit of each strategy alongside the practical trade-off organizations should weigh before adopting it, and the fifth column indicates the corresponding sources.

Table 1 - Risk Management Strategies Matrix

Uncertainty Type	Key Strategies	Resilience Pillar(s) Linked (Sec. I.2)	Resilience Benefit & Trade-off	Sources (2025–2026)
Geopolitical/Tariffs	Nearshoring/Friend-shoring; Multi-sourcing; Route diversification	Flexibility (adaptable sourcing and routing); Collaboration (diversified supplier/partner networks)	Benefit: Reduces single-point failures; insulates from tariff shocks, chokepoint blockages, and regional conflict. Trade-off: Higher unit costs from smaller-scale or geographically dispersed suppliers; added complexity in managing and auditing a wider supplier base.	Renewed nearshoring focus due to tariffs (Gupta, 2026); permanent redesign via nearshoring/friend-shoring to embed tariffs/sanctions scenarios (Lambda Supply Chain Solutions, 2026)
Climate	Climate-risk mapping (hotspot identification); Fortified ports/warehouses; Flexible routing	Visibility (exposure and hotspot mapping); Flexibility (dynamic rerouting); Contingency (fortified backup infrastructure)	Benefit: Minimizes downtime and speeds recovery from extremes. Trade-off: High upfront capital expenditure for infrastructure hardening and monitoring systems; rerouting can temporarily raise transit times and emissions.	Emphasize risk mapping; integrating climate into resilience frameworks (Frank & Radulovic, 2025); adaptation strategies like fortified infrastructure; flexible routing/operational changes (TT Club, 2025)
Regulatory	ESG-integrated supplier scorecards (Scope 3 emissions, human rights, deforestation risk)	Visibility (supplier-level traceability and reporting); Collaboration (supplier engagement on compliance)	Benefit: Proactive compliance avoids penalties and import bans; builds stakeholder trust. Trade-off: Increases administrative and audit burden and costs, particularly for smaller suppliers; risk of supplier attrition where vendors cannot meet scorecard thresholds.	Highlight sustainability-integrated vendor scorecard (Alao et al., 2024)

Because nearshoring, multi-sourcing, and infrastructure hardening vary greatly in how much capital they require, Small and Medium Enterprises (SMEs), which face ongoing cost and financing challenges as highlighted by Bak et al. (2023), cannot effectively pursue all strategies at once. Instead, they should follow a phased adoption plan ordered by the cost-effectiveness of each option in enhancing resilience.

Tier 1 (low capital) prioritizes multi-sourcing for non-critical inputs, while maintaining single sourcing for critical inputs, alongside low-cost visibility tools such as manual risk registers, thereby building flexibility and visibility (Scholten & Schilder, 2015) with little or no capital expenditure.

Tier 2 (moderate capital) extends this to selective dual nearshoring, restricted to the highest-risk stock-keeping units, combined with pooled 3PL partnerships and group-purchasing arrangements that let several SMEs share the fixed costs of insurance, hardened warehousing, and freight consolidation that none could afford alone, thereby extending flexibility and collaboration.

Tier 3 (high capital), facility-level infrastructure hardening scoped to owned or leased warehouses, is deferred until the earlier tiers free up capital or public-private co-investment programs lower the SME's share of the cost, thereby building the contingency pillar that underpins longer-term robustness.

II.1. Strategies analysis

II.1.1. Geopolitical/Tariffs

To address geopolitical tensions and tariff volatility, companies pursue diversification through nearshoring, friend-shoring, multi-sourcing, and route diversification (Gupta, 2026; Lambda Supply Chain Solutions, 2026). Nearshoring relocates production closer to markets, such as U.S. firms shifting from China to Mexico under the USMCA (United States-Mexico-Canada Agreement), or retailers like Walmart, Costco, and Williams-Sonoma reducing their China exposure to 23–40% by 2025–2026, favoring Mexico for upholstery and electronics. Friend-shoring prioritizes partnerships with politically aligned countries (e.g., Vietnam, India, and Southeast Asia via “China +1”). Multi-sourcing engages multiple suppliers for critical components to avoid dependence on a single country, while route diversification combines transportation modes to bypass chokepoints such as the Red Sea/Suez route, rerouting via the Cape of Good Hope or using a mix of sea, rail, and intermodal methods.

These strategies reduce single points of failure, protect operations from regional shocks, lower costs associated with tariffs and disruptions, and promote sustainability through shorter transport distances, reduced emissions, closer supplier proximity, and better oversight of labor practices.

II.1.2. Climate

Physical climate risks are managed through adaptation and infrastructure hardening, including climate-risk mapping, fortified ports and warehouses, and flexible routing (Frank & Radulovic, 2025; TT Club, 2025). Climate-risk mapping uses detailed supply chain exposure assessments paired with weather and climate data to identify vulnerable points exposed to flooding, droughts, heatwaves, or storms over time. Fortified ports and warehouses involve physical upgrades such as raising quay walls, installing drainage and pumping systems, raising assets, and reinforcing structures against extreme weather. Flexible routing employs algorithms and models to dynamically reroute around risky areas during extreme weather, switching to multi-modal backups like rail or road when sea routes are unsafe. These measures reduce downtime, speed recovery, prevent port and warehouse closures, ensure operational continuity, and limit service disruptions. Resilience aligns with sustainability by using durable, low-carbon materials in infrastructure upgrades that reduce resource consumption and CO_2 emissions, and by integrating adaptation with decarbonization.

II.1.3. Regulatory

Regulatory and transitional uncertainty is managed through proactive compliance and carbon procurement, with ESG-integrated supplier scorecards as the primary approach. These scorecards include tracking Scope 3 emissions (requiring suppliers to report and set reduction targets for upstream and downstream emissions), conducting human rights assessments (covering labor practices, modern slavery prevention, fair wages, and safe working conditions through audits and due diligence), and evaluating deforestation risks (ensuring traceability and certification for high-risk commodities like palm oil, soy, leather, cocoa, and timber, in line with EUDR standards).

III. DISCUSSION

The analysis indicates a maturing field in which sustainable logistics resilience is seen as a proactive capability rather than just reactive recovery. The 2025–2026 geopolitical, climate, and regulatory uncertainties detailed in Section I have collectively made risk management essential to improving TBL-aligned logistics performance.

- Theoretical implications

Recent literature emphasizes that isolated approaches, whether focused solely on diversification, digitalization, or compliance, are inadequate in the face of growing disruptions. Instead, resilience arises from the dynamic integration of capabilities: visibility and agility to sense and absorb shocks, flexibility and collaboration to adapt, and balanced redundancy to strengthen overall robustness and enable recovery. Dynamic capabilities theory (Stadtfeld & Gruchmann, 2023) offers a useful perspective, as logistics operators need to continually adjust resources, such as rerouting algorithms and supplier portfolios, under uncertainty while working toward sustainability goals. These views frame risk management not only as a cost center but also as a strategic driver of long-term resilience and net-zero ambitions.

- Resilience–decarbonization tension

Several strategies listed in Table 1 carry a rebound risk. An evident example is route diversification. Sun et al. (2026) measure the emissions impact of rerouting, and the Cape of Good Hope detour (I.3.3) illustrates this mechanism clearly by showing that increased distances lead to higher fuel consumption and Scope 3 emissions, despite restoring service. Similarly, redundancy introduces a comparable risk, as underutilized safety stock and backup capacity add to both the physical and energy footprint of the supply chain.

This tension is well documented. Fahimnia and Jabbarzadeh (2016) show resilience and sustainability are not automatically aligned, and Negri et al. (2021) find the two literatures remain disconnected because sustainability optimizes for efficiency while resilience optimizes for effectiveness. Firms should therefore track emissions intensity as a standing KPI across all uncertainty types, not only climate-triggered ones, pair redundancy and rerouting with offsetting levers (slow steaming, modal shift, SKU-level rather than network-wide safety stock), and require any resilience strategy to clear an emissions ceiling alongside its recovery-time and service-level targets.

- Evidence on ESG scorecard compliance benefits

The strongest evidence involves the human-rights/traceability aspect of the scorecard. Under the US Uyghur Forced Labor Prevention Act, U.S. Customs and Border Protection (CBP) detained 16,755 shipments worth $3.69 billion from June 2022 to July 2025, denying entry to over 10,000 shipments (Parks, 2026). CBP guidance shows that documented supply chain tracing reports can speed up or prevent detention, linking traceability to lower import-ban risk.

Audits, however, show mixed results. Large studies find monitoring reduces violations only with specific designs—trained, pre-announced, buyer-funded audits (Short et al., 2015, 2020)—not automatically. Evidence on remediation (Benstead et al., 2020) describes a process involving targeted audits, NGO partnerships, and worker interviews but lacks a clear timeline. Supplier development costs are not well quantified; this gap means any cost figures should be seen as illustrative, not definitive.

- Limitation of the analysis

This discussion synthesizes recent literature but remains conceptual; empirical validation (e.g., case studies in maritime or automotive sectors) is needed. Rapid developments in 2026 (such as Hormuz blockade dynamics and IMO adoption delays) mean insights should be revisited regularly. The scope also focuses on logistics aspects such as transportation, warehousing, last-mile delivery, and reverse flows, rather than covering the entire end-to-end supply chain (e.g., raw material extraction, manufacturing processes, or downstream retail/consumer activities). While this focus aligns with the paper's emphasis on transportation and distribution vulnerabilities, it excludes deeper exploration of upstream (supplier-side) or downstream (demand-side) dynamics that often amplify risks. Similarly, the analysis prioritizes major global chokepoints and high-impact sectors (automotive, maritime) but gives less attention to underrepresented regions (e.g., Africa, South Asia) and to SME-dominated networks, where resource constraints may limit the adoption of strategies.

CONCLUSION

This paper explores the increasing links between risk management, resilience, and sustainable logistics amidst rising global uncertainties. During 2025–2026, ongoing disruptions—such as ongoing chokepoint crises (Red Sea/Bab el-Mandeb, Strait of Hormuz blockades), trade shifts driven by tariffs, severe weather events (hurricanes, droughts, heatwaves), and transitional issues (EU CBAM final regime starting January 2026 with certificate purchases delayed until 2027; IMO Net-Zero Framework postponed to 2026–2028)—are placing intense strain on logistics networks. These threats amplify vulnerabilities in transportation routes, ports, warehousing, last-mile delivery, and reverse logistics, while increasing Scope 3 emissions and operating costs. The analysis demonstrates that effective risk management is the vital link connecting uncertainty to resilient, TBL-aligned performance. Theoretical perspectives reposition risk management from a reactive cost center to a strategic, enabling, resilient, net-zero-aligned logistics system. Practically, logistics operators must prioritize multi-tier visibility, human-enhanced decision-making, and ESG-integrated planning to navigate this "new normal" of volatility. Policymakers also play a key role by offering incentives for green infrastructure, harmonizing regulations, and coordinating chokepoint resilience at the international level. Although the synthesis offers practical insights, the limitations discussed above underscore the need for ongoing empirical development as this field continues to evolve.

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BIOGRAPHY

Franck MBA DEFFO is a business professional with hands-on operational experience in supply chain forecasting, planning, procurement, inventory management, and project management. He gained his professional experience in industries including Distribution and Logistics, Industrial Manufacturing, and Pharmaceuticals.

Building on this cross-industry operational foundation, he is pursuing a Doctor of Business Administration (DBA) at Wilmington University in Delaware, USA, to deepen his strategic and analytical expertise in supply chain, logistics, and operations management.

His research interests span global logistics networks, supply chain resilience, and sustainability regulation, as well as how religious and spiritual background influences the formation of leadership styles across organizational contexts.