Journal of Applied Economic Sciences
Volume XX, Fall, Issue 3(89), 2025

Supply Chain Risk Management as an Integrated Strategy for Ensuring Stability

Dmytro RASSHYVALOV
https://orcid.org/0000-0002-1404-9302
Department of International Business, ES Institute of International Relations
Taras Shevchenko National University of Kyiv, Ukraine
rasshyvalovd@ukr.net

Botagoz NURAKHOVA (Corresponding author)
https://orcid.org/0000-0002-7220-0226
Narxoz University, Almaty, Kazakhstan
botagoz.nurakhova@narxoz.kz

Oleksandr ALBOSHCHII
https://orcid.org/0000-0001-9329-3698
Department of Logistics Management
National Academy of the National Guard of Ukraine, Kharkiv, Ukraine
alboschiy@ukr.net

Vitalii REIKIN
https://orcid.org/0000-0003-1395-6135
Department of Marketing, Lesya Ukrainka Volyn National University, Lutsk, Ukraine
Vitaliyreikin@gmail.com

Nadiia BOCHAROVA
https://orcid.org/0000-0003-4371-0187
Department of Management, Faculty of Management and Business
Kharkiv National Automobile and Highway University, Ukraine
bocharova.n.a.xnadu@gmail.com

Article's history:

Received 10th of August, 2025; *Received in revised form* 9th of September, 2025; *Accepted* 20th of September, 2025; *Available online*: 30th of September, 2025. *Published* as article in the Volume XX, Fall, Issue 3(89), 2025.

Suggested citation:

Rasshyvalov, D., Nurakhova, B., Alboshchii, O., Reikin, V., & Bocharova, N. (2025). Supply Chain Risk Management as an Integrated Strategy for Ensuring Stability. *Journal of Applied Economic Sciences*, Volume XX, Fall, 3(89), 613 - 636. https://doi.org/10.57017/jaes.v20.3(89).15

Abstract:

This study systematically evaluated integrated risk management (IRM) approaches in global supply chains, examining risk categories, mitigation strategies, technological enablers, and framework gaps. Its aim was to provide a strategic understanding of IRM's role in enhancing resilience and sustainability in volatile environments. Following PRISMA 2020 guidelines, a structured review of 79 peer-reviewed articles (2020–2025) was conducted across Scopus, WOS, JSTOR, and ScienceDirect. A dual-method approach combining thematic synthesis and quantitative descriptive analysis classified findings by risk type, industry focus, mitigation practices, and integration frameworks.

The study found that operational risks were most frequently addressed, with increased attention to cyber and environmental risks. Integrated frameworks emphasizing redundancy, flexibility, real-time analytics, and governance networking are progressively replacing traditional siloed strategies. Technological tools such as AI, IoT, and blockchain have become central to proactive risk prediction and mitigation. In parallel, good governance networking (GGN) has been shown to significantly enhance logistics efficiency and trade responsiveness, reinforcing operational performance and service delivery. This review underscores a multi-level approach, combining technological, organizational, and governance enablers, as essential for resilient and sustainable supply chains in the post-COVID and digitally transformed landscape.

Keywords: mitigation; integrated management; cybersecurity; insurance; digital supply chains; supply chain resilience.

JEL Classification: L23, M11, F63, O33, Q56, C83.

Introduction

In an era of heightened globalization, technological interconnectivity, and geopolitical uncertainty, modern supply chains have evolved into complex, multi-tiered ecosystems that are increasingly exposed to a broad spectrum of risks. The COVID-19 pandemic, climate-related disruptions, cyberattacks, and international trade conflicts have demonstrated the fragility of these networks, revealing systemic vulnerabilities that go beyond isolated operational failures (Mazumdar, 2024; Amoah et al., 2022; Friday et al., 2023). Because of their transboundary interdependence, just-in-time structures, and reliance on digital technologies, modern supply chains are much more vulnerable to cascading disruptions than their linear, static, and frequently regionally focused predecessors (Choi et al., 2023). Thus, for companies that want to be resilient, trustworthy stakeholders, and have an edge in the long run, ensuring supply chain continuity is a top strategic objective, a logistical or operational one.

Amid this landscape, Integrated Risk Management (IRM) has emerged as a strategic paradigm that consolidates risk identification, assessment, mitigation, and governance across operational, cyber, geopolitical, and environmental domains (Jidda Jidda et al., 2025; Moloi & Marwala, 2023). Supply chain stakeholders can benefit from IRM's proactive decision-making capabilities due to the integration of digital technologies, cross-functional coordination, and scenario-based planning, as opposed to isolated risk approaches (Gupta & Srivastava, 2024; Liu et al., 2025). However, despite its rising prominence, the adoption of IRM remains fragmented, and there is a lack of systematic synthesis of its frameworks, success factors, and sector-specific applications. Moreover, literature often focuses narrowly on risk categories or industry-specific disruptions without offering a comprehensive, comparative, and theory-informed evaluation of IRM models.

This gap motivates the current study, which addresses the following core issue: while global supply chains are increasingly vulnerable, there is no integrated academic understanding of how IRM frameworks function across risk types, technologies, and sectors. Consequently, this article aims to provide a holistic and organized synthesis of integrated risk management approaches that support the stability, adaptability, and long-term sustainability of international supply chains.

To achieve this objective, the study poses the following three research questions:

i. What are the dominant integrated risk management (IRM) strategies used to mitigate supply chain disruptions in a globalized, digitized environment?
ii. How do different categories of risks, operational, geopolitical, cyber, and environmental impact the stability and resilience of supply chains?
iii. What are the key factors influencing the successful implementation of IRM frameworks across sectors and geographic regions?

The article is organized into five sections. Section 1 reviews key theories and frameworks in supply chain risk management. Section 2 describes the PRISMA-based methodology, including database selection and analysis procedures. Section 3 presents thematic and quantitative findings on risk types, mitigation strategies, and sectoral trends. Section 4 discusses the implications, identifies research gaps, and outlines limitations. Last section concludes with recommendations and directions for future research.

1. Literature Review

The purpose of this literature review is to establish a structured and theory-informed foundation for understanding integrated risk management (IRM) within supply chains. This section clarifies core concepts including supply chain risk, supply chain stability, and integrated risk management. It further systematizes key classical and modern frameworks, empirical findings, and analytical trends while identifying contradictions and gaps in existing literature to justify the need for this systematic review.

Supply chain risk refers to any internal or external event that disrupts the flow of goods, information, or capital, threatening the achievement of organizational objectives (Altay & Pal, 2023; Chukwuka et al., 2023). These risks may be operational (e.g., delays, failures), geopolitical (e.g., trade disputes), environmental (e.g., natural disasters), or cyber-related (e.g., data breaches), each requiring adaptive management (Ganesh & Kalpana, 2022). While some definitions prioritize physical disruptions (Vital-Soto & Olivares-Aguila, 2023), others adopt a more holistic view, encompassing informational and financial vulnerabilities. These definitional debates underscore the complex, interdependent nature of modern supply chains.

A dynamic approach to uncertainty, Integrated Risk Management (IRM) integrates digital tools to facilitate cross-functional collaboration and scenario planning. It addresses risk systemically across strategic, financial, technological, and operational domains, in contrast to traditional fragmented models (Almashhour et al., 2025; Faisal et al., 2025). (Roieva et al., 2023; Gupta & Srivastava, 2024). Aljohani (2023) found that resilience is enhanced with IRM because it allows for early risk identification, flexibility, and collaborative action. It turns vulnerability into a competitive advantage by moving risk management from a reactive to a proactive approach. Supply chain stability is defined as the capacity to maintain core functions like delivery, service, and profitability during disruptions and complements resilience by emphasizing continuity over recovery (Wieland & Durach, 2021). Resilience is concerned with recovering quickly from setbacks, whereas stability is concerned with absorbing shocks as they happen. Institutional flaws and policy gaps impair stability, as shown in cases like Ukraine's delayed compliance with EU transport safety standards (Pryimak et al., 2024; Koller et al., 2022). Integrating governance and responding to risks at multiple levels are thus necessary for stability.

To analyse such issues, classic models have established a foundation. The SCOR model standardizes supply chain performance benchmarking and has evolved to include risk elements in sourcing and planning (Nguyen, 2024; Nicoletti, 2023). The Risk Exposure Index (REI) is a tool that helps businesses measure their vulnerabilities by connecting supply interruptions to financial losses like falling stock returns or sales (Maddodi & Kunte, 2024). The Supply Chain Disruption Risk Index (SCDRI) builds on this by evaluating volatility through the integration of operational failures and market sentiment (Maddodi & Kunte, 2024).

According to recent research Tretiak et al. (2024), data and decision frameworks play an important role in epistemology. Risk responses are hindered by fragmented knowledge systems, particularly in regulated or cross-border contexts. Hence, integrating data-driven and governance-aligned approaches is key to effective IRM. Modern IRM frameworks also harness technologies like AI, blockchain, and IoT to enhance prediction and responsiveness (Jena, 2025; Ghobakhloo et al., 2023). Yet, many models still treat operational and strategic risks separately, limiting vertical integration across planning horizons (Hariram et al., 2023). Empirical studies on disruptions highlight COVID-19 as a turning point that exposed flaws in just-in-time models and supplier over-reliance (Araujo et al., 2023; Shamsuddoha & Nasir, 2023).

Post-pandemic reforms include dual sourcing, inventory reconfiguration, and nearshoring. Other geopolitical shocks, Brexit and the US-China trade war, prompted firms to diversify sourcing and regionalize operations (Yang & Chan, 2023; Zheng et al., 2025; Harmanci, 2025; Bednarski et al., 2025). In SMEs, supplier collaboration improves operational performance (Audretsch et al., 2023). Environmental and cyber risks add complexity. Disasters from climate change threaten continuity (Durst et al., 2024; Yun & Ülkü, 2023), while digitalization exposes firms to cyberattacks (Takefuji, 2023; Shah & Asghar, 2023).

Government incentives can help SMEs adopt predictive analytics (Rasulov, 2024; Arcidiacono & Torrisi, 2022). Yet most literature lacks integrated, scalable frameworks applicable across sectors. Common themes include proactive risk detection, supplier collaboration, transparency, and digital enablers (Bondar et al., 2024). Simulation techniques (e.g., system dynamics, agent-based models) are underused despite their value (Howick & Megiddo, 2024; Shah, 2024; Shah & Shah, 2024). Debates persist between efficiency (JIT, centralization) and resilience (redundancy, decentralization) (Adana et al., 2024; Thakur-Weigold & Miroudot, 2024).

Effective supply chain management in volatile and complex environments increasingly requires the integration of technological, operational, and organizational enablers. Among these, Good Governance Networking (GGN) has emerged as an important factor in enhancing the efficacy of Integrated Risk Management (IRM) strategies. GGN refers to the structured establishment of collaborative relationships, transparent decision-making processes, and accountability mechanisms across organizational and institutional networks. In the context of IRM, GGN complements traditional risk management practices by bridging operational, technological, and strategic dimensions. It strengthens decision-making capacity, aligns stakeholders' priorities, and facilitates the implementation of risk mitigation measures across complex supply chains. Empirical studies, such as Nicola-Gavrilă et al. (2025), have demonstrated that governance networking significantly improves logistics efficiency and trade responsiveness, illustrating its role as a strategic enabler for resilience. Integrating GGN within IRM frameworks not only optimizes operational performance but also contributes to sustainable and stable supply chain ecosystems, particularly in digitally transformed and post-COVID environments.

Moreover, technological advancement introduces cybersecurity trade-offs. Funding studies also show public-private imbalance in innovation capacity (Dobrovolska et al., 2023). Integrated Risk Management (IRM) in supply chains represents a comprehensive, strategic framework designed to anticipate, assess, mitigate, and monitor a wide array of risks across global value chains (Battaglia et al., 2025). Unlike traditional siloed approaches that address risk reactively within individual departments or firms, IRM operates as a coordinated, cross-functional system that integrates risk governance into the entire supply chain ecosystem (Mahanti, 2021). It encompasses operational disruptions (e.g., supplier failures, logistics breakdowns), environmental shocks (e.g., climate-related events, natural disasters), technological vulnerabilities (e.g., cyberattacks, data breaches), and geopolitical uncertainties (e.g., trade wars, sanctions, and conflicts). Through shared accountability and system-wide visibility, IRM fosters collaboration among stakeholders, manufacturers, suppliers, logistics providers, and regulators to manage complex interdependence in an increasingly volatile global environment. IRM is different because of its reliance on digital technologies and predictive intelligence to transition from reactive to proactive risk management (Bicheva & Valchev, 2023). Orlov et al. (2020) positions the economic dimension as the foundation of corporate sustainability and proposes a methodology to evaluate a firm's "sustainability potential" over the strategic horizon by assessing competitive status, capacity, and the conversion of capabilities into advantages. From an IRM perspective, it offers a governance-oriented KPI scaffold that could align risk and sustainability, but it would benefit from cross-sector benchmarking, longitudinal validation, and integration of supply-chain resilience metrics (e.g., multi-tier visibility, time-to-recovery) to link strategic potential to operational continuity.

Real-time data flows from Internet of Things (IoT) devices, AI-driven analytics, blockchain-enabled traceability, and integrated risk dashboards allow for early warning signals and dynamic response mechanisms. Rather than responding after a disruption occurs, IRM frameworks prioritize pre-emptive mitigation strategies, such as diversified sourcing, scenario modelling, and digital twin simulations. This results in more resilient, transparent, and adaptive supply chains. Ultimately, IRM empowers firms not only to withstand disruptions but also to transform risk into a strategic advantage, reinforcing competitive positioning and long-term sustainability.

Table 1: Conceptual Pillars of Integrated Risk Management (IRM) in Supply Chains

Pillar	Description
Risk Identification and Classification	Systematic mapping and categorization of risks across all supply chain tiers (suppliers, logistics, markets).
Digital Enablement	Utilization of technologies such as AI, IoT, and blockchain to collect real-time data, assess vulnerabilities, and forecast disruptions.
Collaborative Response Mechanisms	Cross-organizational coordination of risk responses through transparent communication and joint mitigation protocols.
Proactive Mitigation	Scenario planning, risk modelling, and preventive strategies such as supplier diversification and predictive analytics.
Feedback and Learning Loop	Integration of historical disruption data into adaptive systems to refine risk strategies and improve resilience over time.

Source: Avcı (2022)

As illustrated in Table 1, the IRM framework is structured around five interdependent pillars that collectively enable proactive, digitally enhanced, and collaborative risk management across global supply chains. The literature is rich but fragmented, as there is no unified framework linking operational tactics to strategic IRM goals across diverse industries. The acceleration of global risk dynamics, technological transformation, and contradictory theoretical directions justifies the need for a structured and systematic review. This review addresses that gap through a rigorous, PRISMA-guided synthesis of contemporary scholarship.

2. Research Methodology

This systematic review was conducted following the PRISMA 2020 guidelines (Page et al., 2021). The primary objective of this review is to systematically evaluate the recent advancements in integrated risk management (IRM) approaches within global supply chains, particularly focusing on their role in ensuring operational sustainability, strategic planning effectiveness, resource optimization, and adaptive management under conditions of uncertainty. The methodology followed a structured protocol covering eligibility criteria, information sources, search strategy, study selection process, data collection, risk of bias assessment, and synthesis methods.

The inclusion and exclusion criteria were carefully designed to ensure that only the most relevant, high-quality studies were selected. It is presented in Table 2.

Table 2: Inclusion and exclusion criteria for study selection

Criteria	Description
Inclusion Criteria	
Peer-reviewed journal articles	Articles published in peer-reviewed academic journals.
Focus on supply chain risk management	Studies that address integrated risk management in relation to supply chain resilience and stability.
Quantitative, qualitative, or mixed-method analysis	Studies employing empirical, theoretical, or mixed-method approaches related to risk typologies and mitigation strategies.
Global context	Studies examining international, multi-sector, or cross-regional supply chains.
Exclusion Criteria	
Non-peer-reviewed sources	Editorials, blog posts, working papers, or opinion pieces.
Irrelevant thematic focus	Articles not directly addressing supply chain risk or integrated risk approaches.
Methodological limitations	Studies lacking methodological rigor, empirical data, or theoretical contribution.
Language restrictions	Articles not published in English.

Note*:* This selection framework ensured inclusion of only high-quality, relevant sources aligned with the study's objectives.

This strict inclusion and exclusion protocol ensured that only studies contributing meaningfully to understanding IRM in supply chains were reviewed.

A thorough literature search was conducted using four prominent academic databases: Scopus, Web of Science, ScienceDirect, and JSTOR. The goal was to carry out a comprehensive evaluation of integrated risk management in supply chains. Keywords such as "cyber risk," "integrated risk management," "resilience," "disruption," and "supply chain risk" were employed to focus the search on articles published between 2020 and 2025. The initial search returned 1,124 articles. This dataset was narrowed to 79 peer-reviewed articles through rigorous inclusion and exclusion criteria. These criteria included relevance to the topic, presence of empirical or theoretical contributions, publication in peer-reviewed journals, and availability in English. Duplicate records were eliminated. Academic rigor and alignment with the core objectives of the review served as the basis for selecting the final sample. The articles that were chosen were thereafter arranged according to their topic focus. Theoretical model and risk framework creation was the subject of fifteen papers, while twenty studies offered empirical evidence from a variety of industries, including healthcare, logistics, hospitality, and manufacturing. Ten more studies highlighted the importance of technology enablers like blockchain, artificial intelligence, and the Internet of Things (IoT) in risk management throughout the supply chain. Insights on regulatory and policy reactions were provided by eight more articles, focusing on the worldwide context of disruptions. The other seventeen papers summed up current strategies, methodologies, and supply chain risk management trends through narrative and systematic reviews. The snowball sampling strategy is used to ensure the review is as thorough as possible. Twelve further articles were added after hand-screening the reference lists of the most cited and thematically relevant articles; these articles offered insightful viewpoints that were missed in the first search. Because of this methodical methodology, the review's literature base was comprehensive, well-rounded, and reflective of contemporary scholarly and professional conversation.

A structured search strategy was implemented using specific keywords and Boolean operators. The search string included (Table 3):

Table 3: Search strategy

Search Component	Description
Keywords	"Supply chain risk management," "integrated risk management," "supply chain stability," "operational sustainability," "strategic planning," "resource optimization," and "adaptive management."
Boolean Operators	("Supply chain" AND "risk management" AND "integrated approach") OR ("supply chain resilience" AND "risk mitigation" AND "operational stability").
Filters	Peer-reviewed articles, English language, publication years 2020–2025.
Search Fields	Title, abstract, keywords.

Note*:* A structured combination of search terms and filters ensured comprehensive coverage of relevant literature.

This approach was designed to capture a wide range of studies addressing both theoretical and practical aspects of IRM in supply chains.

Data Collection Process

The data collection process adhered to the PRISMA 2020 framework to ensure transparency, rigor, and replicability. A systematic search was conducted across major academic databases. Specific inclusion and exclusion criteria were applied to identify relevant peer-reviewed studies. The screening process involved title, abstract, and full-text review stages. Duplicate entries were removed, and only high-quality sources were retained. Table 4 summarizes the number of studies identified, screened, excluded, and included. This structured approach strengthens the methodological integrity of the research.

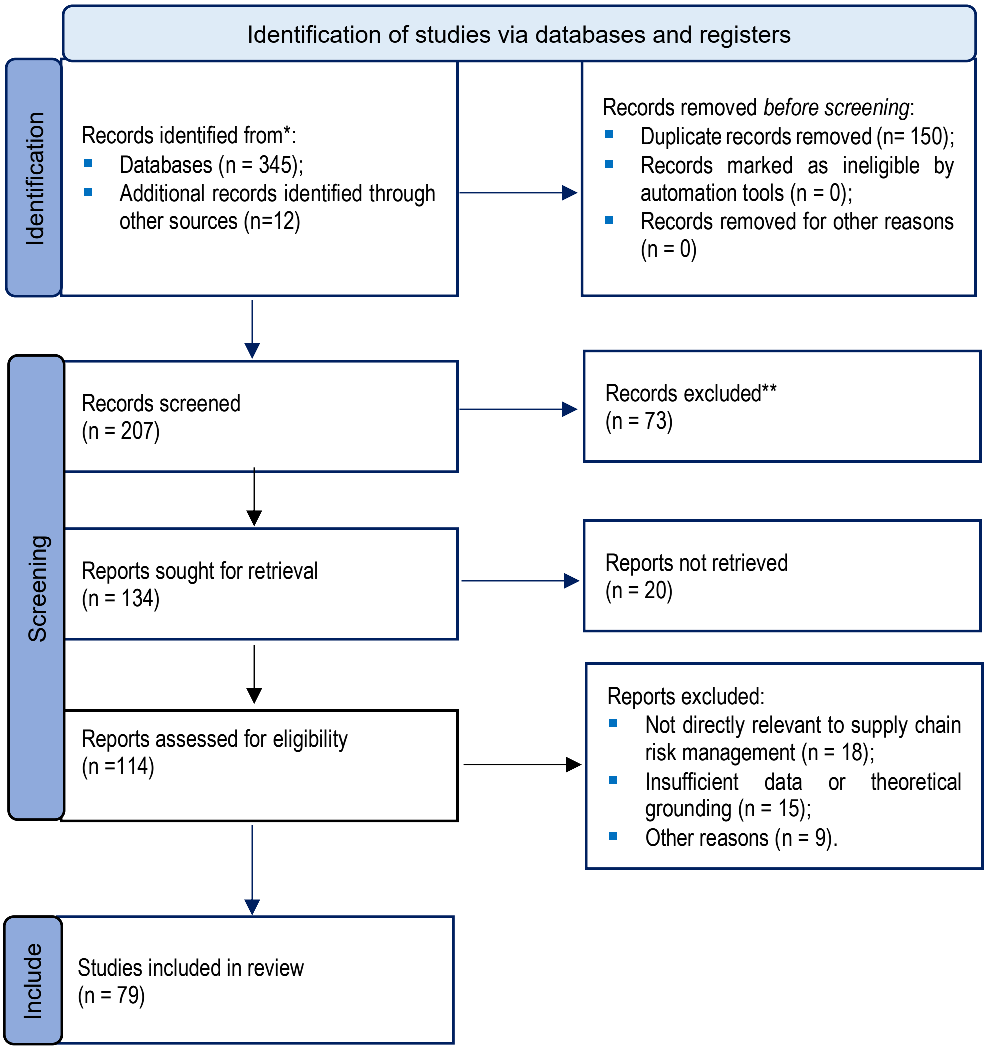
Table 4: Data collection mechanism

Data Collected	Description
Study title, year, authors	Identification details.
Study design	Type of study: empirical, theoretical, case study, or mixed method.
Risk categories addressed	Types of risks analysed, including operational, geopolitical, cyber, environmental risks.
Integrated approach characteristics	Frameworks, models, and tools are applied to support integrated risk management.
Key findings	Main outcomes regarding supply chain stability, operational sustainability, and strategic planning.
Industry and region	Sectoral and geographical context to analyse diversity and generalizability.

Note*:* Structured extraction enabled standardized synthesis across various study types.

The selection process followed the PRISMA 2020 guidelines to ensure methodological transparency and rigor. Four academic databases (Scopus, Web of Science, JSTOR, and ScienceDirect) were systematically searched for peer-reviewed articles published between 2020 and 2025. After removing duplicates and applying predefined inclusion and exclusion criteria, 79 articles were retained for full review. The detailed screening and selection stages are presented in Figure 1, which illustrates the PRISMA flow diagram of the article selection process.

Figure 1: PRISMA flow diagram of article selection process



A modified critical appraisal method was used to check for the risk of bias because the studies in this review were very different, ranging from purely theoretical analyses to empirical investigations. The review focused on four key areas: methodological clarity, theoretical strength, data reliability, and generalizability of the conclusions. The validity and reliability of the data sources, the depth and logic of the theoretical framework, the clarity of the research design and techniques, and the generalizability of the conclusions were all factors considered while evaluating the studies. Three categories for the studies were classified according to the potential for bias: low, moderate, and high. This risk category guided the credibility weighting utilized during the synthesis process to ensure that the results of more substantial research were appropriately weighted in the final analysis.

The literature review was utilized in a dual-method synthesis technique to gain both the breadth and depth of findings. First, quantitative descriptive analysis was used to list the most important patterns. These patterns included how often different types of risk were looked at (operational, geopolitical, cyber, and environmental), how common different integration strategies were, and how studies were spread out across various industry sectors like technology, healthcare, manufacturing, and logistics. This gave a big-picture view of research trends and areas of interest. At the same time, a qualitative thematic analysis was carried out, in which studies were coded systematically based on recurring themes like risk categorization frameworks, integration methodologies, and resilience results. Much coding was done on these themes to find patterns, contradictions, and gaps in the study that were consistent across the paper. Putting studies together based on the type of risk they looked at, the kind of integration (technological, strategic, or adaptable), and the industry sector helped us understand how integrated risk management is considered and used in different situations. The results in this review are complete and reliable because of the comprehensive synthesis method used.

3. Research Results

This section presents the results of the systematic review organized by key themes derived from the 79 studies that were included. Thematic synthesis allowed the categorization of the findings into types of risks, integrated risk management frameworks, mitigation strategies, and emerging technological trends. Quantitative summaries regarding study methodologies, industries analysed, and geographical distribution are also presented. Figures and tables complement the narrative to provide a comprehensive view of the state of research in supply chain integrated risk management (Pu et al., 2023).

The thematic analysis identified four dominant themes across the reviewed studies in Table 5.

Table 5: Thematic analysis of literature

Theme	Description
Types of risks	Operational, geopolitical, cyber, and environmental/climate-related risks.
Mitigation strategies	Supplier diversification, dual sourcing, inventory buffers, cybersecurity investments, and blockchain deployment.
Integration frameworks	Holistic risk management models that integrate operational, financial, and technological risks with resilience principles (e.g., redundancy, flexibility).
Technological enablers	Tools such as artificial intelligence (AI), the Internet of Things (IoT), real-time analytics, and blockchain integration.

Note*:* Thematic synthesis was conducted based on recurring categories across the reviewed studies.

The thematic analysis identified four main themes throughout the analysed studies: hazards, mitigation techniques, integration frameworks, and technological enablers. Each category provides crucial information about supply line integrated risk management changes. The first big idea is book-relevant risks. Supply outages, production problems, and transportation delays have been studied as operating risks. After recent global events, geopolitical threats like trade limitations, tariffs, and political instability are becoming more obvious. More digital supply chains pose cyber vulnerabilities, which is problematic.

Research shows that data breaches, ransomware attacks, and downtimes can weaken systems (Möller, 2023). Environmental and climatic hazards like natural disasters, limited resources, and sustainability rule changes complete the risk picture. These groupings demonstrate that supply chains are now seen as vulnerable to several threats. The second theme is risk-reduction methods. The research demonstrates that reactive techniques are becoming proactive and diverse. Multiple suppliers lessen reliance on a single source; dual sourcing promotes redundancy; and having extra items on hand to address short-term supply shocks are usual practices. Businesses are also investing more in cybersecurity and blockchain technology to secure and track transactions. These solutions demonstrate that researchers and practitioners believe that flexibility, redundancy, and security must be built throughout the supply chain to make anything robust. Supply chain risk integration frameworks have altered the third theme.

According to new research, risk management should not be divided into discrete jobs. Instead, consider it a system with operational, financial, and technological risks. Integrated models emphasize how different types of risk interact and how important it is to see the full system and make the right decisions. Many IRM models emphasize an organization's ability to recover and adapt while maintaining main operations amid stress, laying the framework for resilience theory. Redundancy, agility, adaptability, and cooperation are some of the resilience theory concepts used in modern supply chain designs. Building backup capacity, such safety stock and alternative suppliers, is the key to resilience. Rouieva et al. (2023) and Nitsche et al. (2023) state that being flexible entails adjusting production lines and logistics networks to accommodate unforeseen circumstances. Agility in addressing localized issues without interrupting chains is made possible by real-time data and predictive analytics. When participants in the supply chain adhere to protocols like frequent communication and shared risk agreements, they are better able to coordinate their reactions (Rejeb et al., 2021). Cost reduction and just-in-time (JIT) efficiency take a back seat to long-term survival and uncertainty resilience in these systems. According to recent research, this shift in thinking has become widespread, particularly in the aftermath of the COVID-19 pandemic, when fragile and too optimized supply networks were unable to react (Berbés-Blázquez et al., 2022). Methods for managing risks in the supply chain are shifting their focus from efficiency to robustness (Guerra et al., 2024; Wicaksana et al., 2022). Finally, technological enablers are playing an increasingly important role in integrated risk management. Predicting problems, optimizing resources, and managing backup plans are all areas where AI is finding more applications. Using Internet of Things (IoT) sensors, it can monitor shipments, weather, and asset performance, giving crucial information for making decisions.

Real-time analytics and blockchain platforms make multi-tiered supply networks more accessible and secure, allowing businesses to analyse risk and respond quickly. New technologies make risk reduction successful and advance predictive, data-driven, and adaptable supply chain risk management (Mistarihi & Magableh, 2023). Operational risks like supplier failures, plant shutdowns, and transportation delays dominate supply chain risk management literature. The COVID-19 pandemic broke global supply chains, which used to demonstrate how unexpected demand increases and logistical restrictions disrupt typical operations. Kamalahmadi et al. (2022) emphasize flexibility and redundancy to prevent supplier failures and facility outages.

In our IRM lens, can flags a material exposure for agri-food supply stability, underscoring the need to integrate land-health indicators and carrying-capacity thresholds into risk mapping as Namozov et al. (2024) signalled, with adaptive stocking and pasture-governance controls to mitigate cascading disruptions. Mendoza & Villafuerte (2023) recommend multi-regional supplier networks and dual sourcing to boost operational resilience in crisis-prone ASEAN economies. Even if cyber threats are emerging, operational vulnerabilities are still the most discussed and measured risk in the literature (Friday et al., 2023).

A significant finding of the review is the evolution from isolated risk mitigation tactics to integrated frameworks combining multiple strategies. Traditional approaches like safety stock accumulation and supplier diversification are now often embedded within broader adaptive management frameworks emphasizing flexibility, visibility, and digitalization. Table 6 summarizes the main mitigation strategies discussed across the reviewed studies.

Table 6: Common risk mitigation strategies identified in literature

Mitigation Strategy	Number of Studies	Example Studies
Supplier diversification	32	Fan & Xiao (2023)
Dual sourcing	28	Wieland & Durach (2021)
Cybersecurity investment	18	Möller (2023)
Blockchain for traceability	15	Rauniyar et al. (2023)
Real-time monitoring via IoT	14	Khan et al. (2022)

Note*:* Data reflects frequency and examples of risk mitigation strategies across the 79 reviewed studies.

The data presented in Table 6 highlights the most discussed risk mitigation strategies across the reviewed studies. According to 32 studies, supplier diversification works best. Dual sourcing emphasizes several supply lines for crisis continuation. Safety stock buffers and other ancient approaches still defend against supply chain disruptions. As supply chains become digital and vulnerable to cyberattacks, cybersecurity expenditures are crucial (Jazairy et al., 2024). Technology-enabled risk management strategies attempt to increase transparency, reaction, and prediction. The blockchain for Internet of Things tracking and real-time monitoring is newer. Our thematic distribution reveals that supply lines are transitioning from static, reactive risk management methods to real-time, predictive, and technology-enabled ones. Blockchain and IoT help us detect dangers faster and make decisions based on real-time data (Faisal et al., 2025). This indicates a shift in risk management thinking. Instead of planning for individual hazards, people are creating systems that can react to changing and interrelated risk scenarios. Digital solutions to reduce risks seem helpful and require long-term and sustainable operations as supply chains become more complex and interdependent.

3.1. Risk Categories and Vulnerabilities

When it comes to globalized supply chains, risk exposure is complex and always changing. Digital, environmental, and geopolitical issues have made operational risks worse than they already were. These include delays, stockouts, and equipment failures. These new types of risks are more complicated, harder to predict, and often cross borders. Logistics networks are more vulnerable to cyberattacks, climate shocks, and political instability now that supply models are more interconnected, data-driven, and just-in-time. Because of this, good Integrated Risk Management (IRM) systems need to change so that they can not only find and classify these threats but also come up with plans to deal with them in the future using a mix of technology, coordination, and intelligence.

Contemporary global supply chains are exposed to four interacting families of risk operational, cyber, environmental/climate, and geopolitical effects often cascade across tiers and regions. Operational vulnerabilities arise from lean synchronization, capacity bottlenecks, single-sourcing, and tightly coupled logistics; cyber threats stem from platform interdependence and third-party access that can disrupt planning, fulfilment, and compliance systems; environmental and climate shocks degrade assets and corridors while imposing new disclosure and abatement obligations; and geopolitical shifts tariffs, sanctions, export controls, and conflict reconfigure feasible sourcing sets and elevate border-delay risk.

Because these hazards are compound rather than isolated, an effective IRM posture aligns multi-tier exposure mapping with real-time sensing and predictive thresholds; embeds provenance and assurance to make movements auditable; and operationalizes trigger-based redundancy (e.g., alternate suppliers, routes, and inventory positions) through rehearsed playbooks and decision rights. In practice, this system's orientation converts classification into action: risks are prioritized by consequence and controllability, responses are pre-authorized and time-bound, and technical controls are matched with contractual and financial instruments to ensure enforceable, scalable resilience.

Risks to Cybersecurity

The rise of digital supply chains, which include tools for managing inventory, buying goods, shipping, and clearing customs, has made cyberattacks much more likely. Ransomware, malware injections, and distributed denial-of-service (DDoS) attacks are examples of advanced attacks that can bring down digital infrastructure, make it hard to talk to vendors, and put sensitive customer or transactional data at risk. For example, the 2020 SolarWinds cyberattack got into many public and private sector organizations through a flaw in the software supply chain. This showed how interconnected networks can spread risk. To counteract this risk, IRM systems implement cybersecurity procedures throughout the whole supply chain. Segmenting networks, continuously scanning for vulnerabilities, and sophisticated endpoint detection and response (EDR) technologies are already commonplace in digital risk governance. Unauthorized logins or problems with data transfer can be quickly identified by AI-driven threat intelligence. By taking this measure, businesses may prevent threats from escalating. An further recommendation from IRM is zero-trust designs, which state that no user or device, regardless of their internal or external nature, should be trusted. In the case of a breach, it is becoming more improbable that an unauthorized user might navigate the system due to the continual verification of every access. This criterion is especially important in multi-party ecosystems since unwanted parties might get access to shared platforms and threaten the security of any ecosystem. Finally, supply chain cyber resilience calls for defensive systems that can work together. In areas like cyber exercises, sharing threat intelligence, and incident response planning, key suppliers and partners are being put under pressure by IRM frameworks. Beyond just making people more prepared, this method has two additional benefits: reduced recovery time and reputational loss following cyber catastrophes.

Risks to the Environment and Climate

The threat of climate change to supply chains is now enormous and pervasive. Hurricanes, heat waves, wildfires, and floods are examples of extreme weather that hinder transportation, demolish infrastructure, and lead to raw material shortages. Floods may clog ports and warehouses, increasing logistical costs and lengthening delivery times, while droughts in agricultural regions reduce food harvests. Supply chain design and planning now must account for these environmental changes, which are no longer one-time occurrences but rather occur repeatedly. Research conducted by Zavhorodnii et al. (2021) on the vegetable supply in Ukraine from the Black Sea region demonstrates how agricultural digitalization, which is facilitated by information and communication technology (ICT), reduces paperwork, expedites processes, improves output quality, and increases competitiveness in the long term. By speeding up decision-making, increasing visibility and traceability, and boosting operational efficiency, digital enablement strengthens agri-food chains' resilience and stability, according to our IRM framework.

IRM helps with these problems by adding geospatial analytics and climate forecasting tools to the process of making decisions about the supply chain. Satellite images, weather sensors, and hydrological models can help companies plan by giving them early warning signals and mapping out areas that are more likely to be affected. This lets them change the route of shipments or change the amount of stock they have on hand. Companies can now figure out how sensitive certain suppliers or nodes are to climate change and allocate resources accordingly.

Risk heatmaps, which use both historical and real-time data, are another way to assess risk by location. These visual aids help managers find places where people are most at risk, like warehouses that are likely to flood or suppliers that are likely to dry up and start taking steps to protect them. This could mean moving stock to safer places, strengthening physical infrastructure, or making rules for buffer stock for items that are at risk. As a way to adapt to climate change, IRM also supports the diversification of logistics networks and sourcing strategies. Companies are moving away from relying on a single supplier in vulnerable areas. Instead, they are choosing geographically distributed supplier portfolios and multimodal transport options that give them more options in bad weather. Environmental risk planning is no longer optional in fields that have a lot of impact, like agriculture, energy, and textiles. Carbon prices and regulations on the disclosure of sustainability data are examples of the increasing regulatory pressures. Therefore, environmental risk is now an integral aspect of enterprise-wide IRM strategies. To understand the impact of COVID-19 on food security, Vasylieva (2021) examines the price trends in Ukraine and surrounding EU nations. She draws a connection between interrupted supply chains, declining buying power, and decreased availability and affordability. To stabilize agri-food systems during systemic crises, it is important to have coordinated policy and supply measures, such as targeted buffers, safety nets, and trade facilitation. Cross-border price surveillance can serve as an early warning signal in this context.

Geopolitical Risk

Geopolitical risk has emerged as a key destabilizing factor for supply chains due to the rise of nationalism, trade fragmentation, and ongoing military conflicts. Trade disputes between big economies (like the US and China), sudden tariffs, sanctions on important raw materials, and even war, like the one between Russia and Ukraine, can quickly change the availability, cost, and legality of cross-border trade. Political instability in areas with important ports or rare earth reserves can quickly spread through global production networks. IRM systems use geopolitical scenario planning and monitoring tools to figure out how these kinds of events might affect things. This includes keeping up-to-date geopolitical risk indices, looking at changes in trade policy, and working with lawyers and compliance experts to prepare for sanctions or embargoes. Companies can pretend to use different trade routes, switch suppliers, or change the way demand works in response to changes in the world. Localized sourcing and nearshoring are important ways to respond. This means moving suppliers closer to markets where they are consumed to avoid unstable geopolitical corridors. This may make things less cost-effective in the short term, but it makes them more resilient and responsive in the long term. Companies are also looking over their contracts again to make sure they have clauses for political risk insurance and flexible delivery terms in case things get uncertain. Blockchain and other technologies help manage geopolitical risk by proving where goods come from, which is especially useful when you need to show that you aren't involved with sanctioned groups. When certain borders close or regions are put under embargo, real-time supply chain visibility also makes it easier to adapt quickly. IRM also says that governments and multilateral institutions need to work together more closely to make sure that risk intelligence is based on the most recent geopolitical assessments. In sectors that are vulnerable to geopolitical issues, like defence, mining, and pharmaceuticals, public-private partnerships, diplomatic monitoring, and regional contingency planning are becoming more common.

3.2. Study Methodologies, Industries, and Geographic Focus

Manufacturing dominates due to its complex, worldwide supply systems. Due to their importance during pandemics, logistics and healthcare attract more emphasis. Although North America and Europe dominate, recent studies examine supply chain risks in Asia-Pacific, especially in emerging economies like Kazakhstan, revealing regional weaknesses and adaptive methods. The most popular research method is qualitative case studies, at 45%. Many of these case studies examine how real-world disasters like earthquakes, pandemics, and geopolitical events affect supply chain performance. Qualitative techniques provide detailed, situation-specific information about how businesses handle disturbances, adapt, and adjust supply chain strategy.

Quantitative surveys and statistical modelling, which make up 35% of studies, provide generalized, empirical proof of risk management across bigger groups. Qualitative and quantitative data models are also growing (20%). People are realizing that contextual depth and statistical generalizability are needed to grasp integrated supply chain risk management's complexity (Table 7).

Table 7: Study methodologies employed in the reviewed literature

Methodology Used	Number of Studies	Percentage
Qualitative case studies	27	45%
Quantitative surveys/statistical modelling	21	35%
Mixed methods (qualitative + quantitative)	12	20%

Note*:* Qualitative studies were particularly common in empirical analyses of real-world disruptions such as COVID-19 lockdowns and natural disasters.

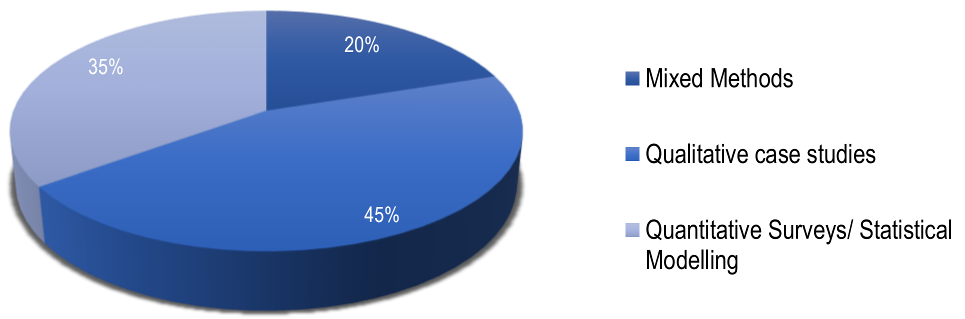
A further dimension emerging in recent scholarships is the integration of interdisciplinary and technology-driven methodologies into supply chain risk management studies. Beyond traditional qualitative and quantitative approaches, researchers are increasingly combining operations research, behavioural sciences, and digital analytics to capture the multifaceted nature of disruptions. For instance, the adoption of big data analytics and machine learning techniques has expanded the ability to model and forecast risks with higher accuracy, especially in contexts such as pandemic outbreaks or sudden geopolitical shocks. Studies employing digital twin simulations and blockchain-enabled traceability systems have demonstrated how real-time monitoring can enhance both predictive and adaptive capacities. Meanwhile, behavioural science methods are used to explore managerial decision-making under uncertainty, revealing the cognitive biases that often exacerbate systemic vulnerabilities. This convergence of technological tools and social science perspectives underscores a paradigm shift: risk management is no longer viewed solely as an operational safeguard but as a strategic capability embedded within global value networks. This trend also suggests that future research will increasingly rely on hybrid methodologies linking contextual depth, statistical generalizability, and computational modelling to provide both explanatory and predictive insights into supply chain resilience.

An additional insight from the reviewed literature is that methodological choices often align closely with industry- or region-specific contexts. For instance, case-based and qualitative designs dominate studies in emerging economies such as Kazakhstan, where limited datasets and fragmented institutional structures make in-depth, contextually grounded exploration more feasible than large-scale statistical surveys. In contrast, research on North American and European manufacturing and logistics systems frequently employs quantitative modelling and simulation techniques, reflecting stronger data infrastructures and established research traditions.

Mixed-methods studies, though less common, are increasingly used in healthcare and agri-food supply chains where both numerical forecasting and contextual interpretation are important for addressing regulatory complexities and perishability risks. This suggests that methodological diversity is not merely a scholarly preference but a response to the data environments, industrial dynamics, and governance conditions under examination.

As illustrated in Figure 2, qualitative case studies represent the largest share of methodological approaches at 45%, followed by quantitative surveys/statistical modelling (35%) and mixed methods (20%). This distribution highlights the predominance of qualitative inquiry, while also showing a substantial reliance on quantitative and integrative approaches.

Figure 2: Methodologies in the reviewed literature



Note*:* Data represents percentage distribution based on 60 reviewed studies.

The manufacturing sector, especially automotive and electronics, is the focus of 26 studies, making it the most researched business (Table 8).

Table 8. Industries represented in the reviewed studies

Industry	Number of Studies
Manufacturing (automotive, electronics)	26
Logistics and transportation	14
Healthcare and pharmaceuticals	10
Agriculture and food supply	6
Technology (IT, cybersecurity)	4

Note*:* Manufacturing and logistics sectors are the most frequently studied, reflecting their centrality in global supply chains.

Since industrial networks are complex, global, and susceptible to supply chain shocks, this makes sense. Given their importance for transferring commodities and vulnerability to border prohibitions, regulation changes, and inadequate infrastructure, logistics and transportation receive a lot of attention. After COVID-19, supply chain resilience was essential to ensure basic supplies were constantly available, making healthcare and pharmaceuticals more important. Agriculture, food supply, and technology (IT, cybersecurity) are not studied as much as other sectors, but their inclusion shows that people are becoming more aware of challenges unique to their fields, such as food security and cyber threats in digital supply chains. North America (24), Europe (18), and Asia-Pacific (12), with a concentration on Kazakhstan and other rising countries, have the most research. This distribution indicates a focus on developed regions with better supply chain networks and data availability. Asia-Pacific situations, especially emerging countries, are good to include. Studies of Kazakhstan and similar countries reveal weaknesses, limited resources, and unique adaptations. Global and international research are rare, but those that exist adapt their findings abroad.

Sector-Specific Risks: Focus on Agri-food Supply Chains

The agri-food sector is especially vulnerable to problems in the supply chain because its products spoil quickly, there are strict rules, and production cycles are limited to certain times of the year. Agricultural goods like fruits, vegetables, dairy, and meat don't last if durable goods and are very sensitive to temperature, humidity, and how they are handled. Even small delays in storage or shipping can cause things to go bad, get contaminated, and cost a lot of money. Also, because food supply chains are globalized and inputs and outputs often cross many borders, they are more likely to be affected by regulatory mismatches, phytosanitary risks, and customs delays. Because of this, agri-food logistics need an Integrated Risk Management (IRM) approach that is very flexible, open, and based on technology. Cold-chain monitoring is one of the most important tools in agri-food IRM. It uses IoT-enabled sensors to make sure that perishable goods are stored and moved at safe temperatures. All the time, these sensors are taking readings from their surroundings and sending out warnings if anything is amiss. Logistics firms can then reroute, recycle, or expedite deliveries as needed. Because even brief exposure to temperature variations can compromise the safety and efficacy of sensitive or valuable commodities, this is of the utmost importance whether it comes to seafood, vaccinations, or dairy.

Businesses may utilize cold-chain visibility to better comply with increasingly strict food safety rules while also preventing food from rotting. Additionally, blockchain technology allows for easier tracking and monitoring of the agri-food supply chain. With blockchain technology, all parties involved in a transaction, from farmers and processing facilities to distributors and merchants, can be assured that their data will be secure. Because of this, it is easier to pinpoint where the dishonesty or contamination originated. In situations where every second counts, like a food recall or a public health catastrophe, this skill is priceless. In this regard, Walmart's food traceability initiative is a well-known usage of blockchain technology. Thanks to it, the process of tracing a shipment of mango slices dropped from seven days to only 2.5 seconds. Not only can these kinds of digital assurance solutions lessen the impact and cost of problems, but they also provide customers with additional peace of mind. Artificial intelligence (AI) enhances integrated risk management (IRM) in the agri-food sector by making the supply chain more efficient, which boosts yields while cutting food waste.

Artificial intelligence algorithms can figure out when to harvest crops best by looking at soil data, market demand, and weather forecasts. Thanks to this, we were able to cut down on waste while still meeting our logistical capacity for production. Warehouses and distribution centers utilize AI to sort goods by temperature at destination, seller stock, and how quickly they tend to spoil. The use of AI simplifies the process of presenting the most recent things to customers by automating these complex trade-offs. Bad things happen food spoils, supplies disappear, and atmospheric carbon dioxide levels rise. By integrating these technologies, a robust IRM architecture that is customized to meet the needs of the agri-food business is created. When combined, the IoT, blockchain, and AI turn risk management into a proactive system that can keep an eye on the supply chain in real-time, check that food is safe, and keep quality standards met. Food production is being influenced by several factors, including changing weather patterns, the complexities of international trade, and rising population numbers. Strength and durability in agri-food systems can only be achieved via the judicious application of digital IRM techniques.

4. Discussion

Relative to fragmented or functionally siloed approaches, integrated risk management (IRM) architectures are associated with measurable gains in continuity, recovery, and service performance, according to multiple empirical and practitioner-facing studies that have been reviewed in the literature. Digitally enabled, cross-functional IRM leads to faster recovery, lower crisis-related revenue variability, and higher customer satisfaction, according to evidence from multi-case analyses and cross-sector evaluations (Birkel et al., 2023; Deszczyński, 2021; KPMG Global Supply Chain Survey, 2022; Mendoza & Villafuerte, 2023). The results show that redundancy, flexibility, collaboration, and timely information improve a system's shock absorption and adaptation capabilities, which is a key tenet of resilience theory. What's more, these findings extend previous models by showing that these principles work better when integrated into a coordinated, data-governed IRM system. In line with current research on explainable AI and operational agility, which emphasizes the need of predictive analytics and quick problem localization for responsiveness, these findings are in agreement with Kosasih et al. (2024). Literature suggests that technology tools (such as AI, IoT, and blockchain) should be seen as means to a goal rather than the be-all and end-all of risk response (Rauniyar et al., 2023).

Concurrently, ability and circumstance determine the extent to which benefit is actually achieved. According to research, the effectiveness of technology-intensive IRM is influenced by factors such as digital maturity, funding capacity, and collaborative culture (Nguyen et al., 2023; Kuguoglu et al., 2021). Instead of being transferred as a homogeneous template, our synthesis emphasizes context-aware integration, which means that IRM should be customized to sectoral risk profiles and geographical restrictions. Lastly, operational IRM can be supplemented by risk-transfer instruments that are integrated into digital workflows. From redefining insurance as post-loss indemnity to pre-emptive risk coordination, practitioner evidence suggests that insurance linked to IoT telemetry and smart-contract triggers improves real-time response (e.g., conditional coverage activation, expedited "green-lane" handling) (Aon, 2022; Deloitte, n.d.). This further supports the overarching idea that for IRM to be effective, technology, governance, and financing must be co-designed.

Two longstanding schools shape supply chain design. The efficiency-oriented view favours lean/JIT operations and minimal buffers; the redundancy-resilience view advocates deliberate slack (e.g., diversified suppliers, safety stock) to absorb shocks. Recent disruptions exposed the fragility of purely efficiency-driven designs, while the literature also shows that ungoverned redundancy can be costly and opaque (Alfina et al., 2025; Kamalahmadi et al., 2022). Our findings support a hybrid position: resilience need not imply permanent inefficiency when redundancy, flexibility, and buffers are selectively activated, forecast-informed, and digitally orchestrated (e.g., AI-guided dual sourcing, dynamic inventory positioning), thereby reconciling efficiency with robustness (Kosasih et al., 2024).

In our IRM context, source separation combined with valorisation pathways, such as biogas, energy recovery, and composting, can convert waste into economically valuable inputs, as Belgibayeva et al. (2024) find. This highlights a clear environmental–infrastructure gap and suggests a practical circular-economy route to strengthen regional supply chain resilience through traceable collection, recycling infrastructure, and waste-to-value integration.

A related contradiction concerns globalization. One camp argues international diversification reduces location-specific risk (Buriak et al., 2023; Fan & Xiao, 2023); the other warns that extended networks increase complexity, opacity, and systemic exposure (Grossman et al., 2023). Our synthesis suggests the resolution is not "global vs. local," but governed modularity: regionally balanced, visibility-rich networks that can reconfigure under geopolitical, environmental, or cyber constraints an IRM-consistent stance that directly motivates the research gaps identified in Section 3.

Walmart leverages blockchain-based traceability in agrifood chains to compress trace times from days to seconds, strengthening recall precision and regulatory compliance an enactment of visibility and provenance within IRM (Patel, 2025; see also Pal et al., 2025 for agrifood blockchain). DHL deploys AI-enabled forecasting and IoT telemetry to anticipate route disruptions and equipment anomalies, enabling predictive rerouting and proactive maintenance that embody flexibility and agility (Soumpenioti & Panagopoulos, 2023; Potwora, et al., 2023; Behera & Dave, 2024). Maersk combines blockchain document flows and IoT-equipped containers to enhance customs visibility and tamper-resistant documentation, reducing delay risks and facilitating secure, auditable handoffs (Rosário & Dias, 2023; Gereffi et al., 2021; Mazumdar, 2024). Together, these cases affirm the review's emphasis on digital maturity, data governance, and cross-organizational coordination as the practical levers through which IRM converts theory into superior operational performance (see also Aon, 2022; Deloitte, n.d.).

The evidence base supports transitioning from static, siloed taxonomies to ecosystem-level, adaptive models that capture cross-domain propagation (e.g., cyber incidents triggering operational failures). This perspective integrates systems theory, adaptive management, and data governance, and calls for formal tools that model feedback and interactions, not just point estimates (Kosasih et al., 2024). Managers should prioritize bundled capabilities: multi-tier visibility, scenario playbooks mapped to decision rights, calibrated redundancy (dual/nearshored sourcing; dynamic safety stock), and cyber-physical safeguards.

Technology adoption should follow a staged roadmap visibility, prediction, automated response aligned with organizational readiness (Nguyen et al., 2023; Kuguoglu et al., 2021). Where relevant, embedded insurance can be integrated as a real-time risk-transfer adjunct (Aon, 2022; Deloitte, n.d.). Policymakers can amplify IRM by incentivizing interoperable data standards, secure sharing utilities, and SME-friendly platforms, as well as by supporting testbeds that validate cross-border traceability and compliance (Gereffi et al., 2021).

Manufacturing and logistics dominate; agri-food, energy, and healthcare remain under-examined despite distinct perishability, regulatory, and critical-infrastructure risks (Mendoza & Villafuerte, 2023; Pal et al., 2025). A dearth of longitudinal designs constrains understanding of capability maturation and decay. Further, multi-risk interaction models linking cyber, geopolitical, environmental, and operational cascades are still rare (Kosasih et al., 2024; Kamalahmadi et al., 2022). Evidence concentrates in North America and Europe; emerging regions with different institutional and capacity profiles are underrepresented, limiting generalizability (Nguyen et al., 2023; Buriak et al., 2023). Cost, skills, cybersecurity posture, and organizational inertia continue to impede IRM implementation; successful scaling requires governance and workforce development in tandem with tools (Kuguoglu et al., 2021; Rauniyar et al., 2023).

Limitations and Directions for Future Research

This discussion is bounded by the review's English-language scope and database coverage, which may bias findings toward certain regions and publication venues. Addressing the gaps above will require comparative case studies spanning sectors and geographies (to test contextual fit and transferability); simulation-based analyses (e.g., system dynamics, agent-based) to quantify multi-risk propagation and policy trade-offs; and longitudinal designs to track the evolution of IRM capabilities and outcomes over time (Kosasih et al., 2024; Kamalahmadi et al., 2022). Studies that evaluate staged adoption roadmaps in developing contexts and that assess the incremental value of embedded risk-transfer mechanisms (Aon, 2022; Deloitte, n.d.) fill critical practical and theoretical gaps. Finally, work that explicitly links data governance quality to IRM performance would clarify when and how digital enablers (AI/IoT/blockchain) deliver causal improvements (Birkel et al., 2023; Rauniyar et al., 2023).

Conclusion

Modern supply chains' increasing complexity, interconnectivity, and exposure to volatile disruptions necessitate a departure from traditional, reactive, and siloed risk management practices. This systematic evaluation of 79 peer-reviewed publications found that integrated risk management (IRM) is necessary for organizations to maintain continuity, resilience, and competitive advantage in a volatile global market. The top information risk management (IRM) systems integrate a single architecture with capabilities including redundancy, adaptability, real-time monitoring, and predictive analytics, as stated in this evaluation. Automated decision-making, early risk identification, and transparency were all greatly improved by methods supported by AI, the Internet of Things (IoT), and blockchain. These solutions allow for dynamic disruption management, but their effectiveness is dependent on an organization's digital maturity, financial investment, and internal capacity for change. Most of the research on the implications of different risks on the stability and resilience of supply chains still focuses on operational risks, like transportation delays and supplier failures, because of the obvious and immediate consequences. In contrast, the analysis shows that cyber threats and environmental disruptions are on the rise and that these two factors contribute to systemic and domino consequences of problems. Considering geopolitical risks like trade disputes and regional crises, businesses are rethinking their network architectures and pushing for greater geographic variety and adaptability.

The research also identifies several key enablers that influence the efficient implementation of IRM frameworks. Among the most crucial are cross-departmental collaboration, dedicated leadership, digital infrastructure investment, supplier collaboration, and adaptable governance frameworks. It becomes evident that IRM approaches can move from conceptual planning to efficient operational integration when these considerations are considered. Many issues, including inadequate infrastructure, digital gaps, and ineffective governance, make it difficult for organizations in emerging economies to implement IRM.

The review suggests many practical implications based on these findings. Instead of seeing IRM as a compliance measure, management should see it as an essential component of both the long-term strategy and the day-to-day operations. As part of this, there will be investment in predictive technology, strengthening our supplier networks, and use digitally enabled, frequently tested risk response procedures. Viewing strategic redundancy as an asset rather than a negative enhances the ability to adapt to changing conditions. Policymakers must promote supply chain visibility, interoperability of digital tools, and cross-border data sharing to promote risk transparency. To prevent resilience from being a luxury enjoyed by a select few, it is critical to encourage small and medium-sized businesses to use cost-effective risk management strategies. Public-private collaborations and industry-specific resilience standards can help national economies incorporate IRM ideas even further.

Based on the findings of this paper, academics should conduct empirical tests of IRM frameworks in a variety of business settings. To better comprehend the temporal and shock-dependent evolution of risk behaviours, future investigations should give preference to simulation-based research and longitudinal case studies. Research must immediately expand from the manufacturing sector to other areas with unique vulnerabilities and policy ramifications, such as healthcare, agriculture, and energy. In addition, developing nations need further research on the flexibility of IRM frameworks because their institutional settings and structural limitations are unique. Recognizing that disruptions do not happen in a vacuum but frequently collaborate to increase susceptibility across supply chain nodes, theoretical development should lastly progress toward modelling interconnected hazards. Integrated risk management is both a shield and a strategy for surviving and thriving amid global uncertainty. While risks in supply chains cannot be eliminated, organizations can build intelligent, adaptive systems that predict, absorb, and evolve in response to disruption. Such systems are essential for ensuring the sustainability and competitiveness of supply chains in the 21st century.

Credit Authorship Contribution Statement

The authors contributed to the study as follows. Conceptualization was carried out by Rasshyvalov, D and Nurakhova, B., as corresponding author. Data curation was performed by Alboshchii, O. and Reikin, V. Formal analysis was undertaken by Nurakhova, B and Alboshchii, O. Methodology was developed by Bocharova, N. and Reikin, V. Project management was ensured by Rasshyvalov, D. Supervision was provided by Bocharova. N. Validation was conducted by Reikin, V. and Alboshchii. O.

Acknowledgments/Funding

The authors did not receive financing for the development of this research.

Conflict of Interest Statement

The authors declare that there is no conflict of interest.

Data Availability Statement

The data that support the findings of this study are openly available.

References

Adana, S., Manuj, I., Herburger, M., Cevikparmak, S., Celik, H., & Uvet, H. (2024). Linking decentralization in decision-making to resilience outcomes: A supply chain orientation perspective. *The International Journal of Logistics Management, 35*(1), 256–280. https://www.emerald.com/insight/content/doi/10.1108/ijlm-07-2022-0308/full/html

Alfina, K. N., Ratnayake, R. M., Wibisono, D., Basri, M. H., & Mulyono, N. B. (2025). Enhancing resilience and sustainable healthcare supply chains: Integrating circular economy and dynamic barrier management. *Discover Sustainability, 6*(1), 1–35. https://link.springer.com/article/10.1007/s43621-025-01270-1

Aljohani, A. (2023). Predictive analytics and machine learning for real-time supply chain risk mitigation and agility. *Sustainability, 15*(20), 15088. https://doi.org/10.3390/su152015088

Almashhour, R., Al-Mhdawi, M. K. S., Daghfous, A., Qazi, A., & Ojiako, U. (2025). Traditional to sustainable risk management in the construction industry: A systematic literature review. *International Journal of Managing Projects in Business*. https://doi.org/10.1108/IJMPB-01-2025-0021

Altay, N., & Pal, R. (2023). Coping in supply chains: A conceptual framework for disruption management. *The International Journal of Logistics Management, 34*(2), 261–279. https://doi.org/10.1108/IJLM-05-2021-0305

Amoah, K., Gyamfi, E., & Mensah, R. O. (2022). A Study on the Elasticity of Time in a Perceived Polychronic Culture. *Mediterranean Journal of Social Sciences*, *14*(2), 1. https://doi.org/10.36941/mjss-2023-0009

Aon. (2022). *Mitigate supply chain risk with trade disruption insurance*. https://www.aon.com/insights/articles/2022/mitigate-supply-chain-risk-with-trade-disruption-insurance

Araujo, R., Fernandes, J. M., Reis, L. P., & Beaulieu, M. (2023). Purchasing challenges in times of COVID-19: Resilience practices to mitigate disruptions in the health-care supply chain. *Journal of Global Operations and Strategic Sourcing, 16*(2), 368–396. https://doi.org/10.1108/jgoss-04-2022-0026

Arcidiacono, A., & Torrisi, G. (2022). Decentralization and resilience: A multidimensional approach. *Sustainability, 14*(16), 9919. https://www.mdpi.com/2071-1050/14/16/9919

Audretsch, D. B., Belitski, M., Caiazza, R., & Phan, P. (2023). Collaboration strategies and SME innovation performance. *Journal of Business Research, 164*, 114018. https://www.sciencedirect.com/science/article/pii/S0148296323003764

Avcı, M. G. (2022). An integrated risk management framework for global supply chains. *Journal of Advanced Research in Natural and Applied Sciences, 8*(4), 624–640. https://doi.org/10.28979/jarnas.1105502

Battaglia, M., Ceglia, I., Calabrese, M., & Iandolo, F. (2025). Systemic risk management and stakeholder engagement: Insights from business CSR disclosure. *Corporate Social Responsibility and Environmental Management, 32*(3), 4295–4314. https://onlinelibrary.wiley.com/doi/abs/10.1002/csr.3186

Bednarski, L., Roscoe, S., Blome, C., & Schleper, M. C. (2025). Geopolitical disruptions in global supply chains: A state-of-the-art literature review. *Production Planning & Control, 36*(4), 536–562. https://www.tandfonline.com/doi/full/10.1080/09537287.2023.2286283

Behera, T. K., & Dave, D. M. (2024). From reactive to proactive: Predicting and optimizing performance for competitive advantage. In *Transforming industry using digital twin technology* (pp. 69–93). Springer Nature Switzerland. https://link.springer.com/chapter/10.1007/978-3-031-58523-4_5

Belgibayeva, A., Tumalavicius, V., Petrova, M., & Akhmedyarov, Y. (2024). Economic aspects of organic waste disposal in the Republic of Kazakhstan. In *BIO Web of Conferences* (Vol. 114, p. 01006). EDP Sciences. https://doi.org/10.1051/bioconf/202411401006

Berbés-Blázquez, M., Schoon, M., Benessaiah, K., Bennett, E. M., Peterson, G. D., & Ghimire, R. (2022). Resilience in the times of COVID: What the response to the COVID pandemic teaches us about resilience principles. *Ecology and Society, 27*(2), Article 16. https://ecologyandsociety.org/vol27/iss2/art16/

Bicheva, P., & Valchev, E. (2023). Methodology for implementation of intelligent risk management in the business processes of organizations. In *Intelligent sustainable systems: Selected papers of WorldS4 2022. Volume 1* (pp. 127–139). Springer Nature Singapore. https://link.springer.com/chapter/10.1007/978-981-19-7660-5_12

Birkel, H., Hohenstein, N. O., & Hähner, S. (2023). How have digital technologies facilitated supply chain resilience in the COVID-19 pandemic? An exploratory case study. *Computers & Industrial Engineering, 183*, 109538. https://www.sciencedirect.com/science/article/abs/pii/S0360835223005624

Bondar, A., Tolcheva, G., Bilyk, M., Slavkova, O., & Symonov, V. (2024). The role of digitalization in management and adoption of strategic decisions in modern management. *Financial and Credit Activity: Problems of Theory and Practice, 2*(55), 214–227. https://doi.org/10.55643/fcaptp.2.55.2024.4349

Buriak, I., Kalynovskyy, A., Pasko, M., Saienko, V., & Zavolichna, T. (2023). Actual problems of management and public administration in modern globalization processes. *Pacific Business Review International, 16*(4), 122–133. https://www.researchgate.net/publication/382658989_Actual_problems_of_management_and_public_administration_in_modern_globalization_processes

Choi, T. Y., Netland, T. H., Sanders, N., Sodhi, M. S., & Wagner, S. (2023). Just-in-time for supply chains in turbulent times. *Production and Operations Management*. https://doi.org/10.1111/poms.13979

Chukwuka, O. J., Ren, J., Wang, J., & Paraskevadakis, D. (2023). Comprehensive research on analysing risk factors in emergency supply chains. *Journal of Humanitarian Logistics and Supply Chain Management, 13*(3), 249–292. https://doi.org/10.1108/JHLSCM-10-2022-0108

Deloitte. (n.d.). *Deloitte and Nexxiot announce strategic KYX partnership for logistics*. https://www.deloitte.com/ch/en/about/press-room/deloitte-and-nexxiot-announce-strategic-kyx-partnership-for-logistics.html

Deszczyński, B. (2021). Relationship management maturity. In *Firm competitive advantage through relationship management: A theory for successful sustainable growth* (pp. 67–120). Cham: Springer Nature. https://link.springer.com/chapter/10.1007/978-3-030-67338-3_3

Dobrovolska, O., Sonntag, R., Ortmanns, W., Kadyrus, I., & Rudyanova, T. (2023). Structural and comparative analysis of R&D funding impact on the level of innovation development: The empirical evidence of GII's leaders and Ukraine. *Innovative Marketing, 19*(4), 310–322. https://doi.org/10.21511/im.19(4).2023.25

Durst, S., Hinteregger, C., & Zieba, M. (2024). The effect of environmental turbulence on cybersecurity risk management and organizational resilience. *Computers & Security, 137*, 103591. https://www.sciencedirect.com/science/article/pii/S0167404823005011

Faisal, S. M., Khan, W., & Ishrat, M. (2025). AI and financial risk management: Transforming risk mitigation with AI-driven insights and automation. In *Artificial Intelligence for Financial Risk Management and Analysis* (pp. 281–306). IGI Global. https://doi.org/10.4018/979-8-3373-1200-2.ch014

Fan, D., & Xiao, C. (2023). Firm-specific political risk: A systematic investigation of its antecedents and implications for vertical integration and diversification strategies. *International Journal of Operations & Production Management, 43*(6), 984–1007. https://www.emerald.com/insight/content/doi/10.1108/ijopm-02-2022-0094/full/html

Friday, D., Ryan, S., Melnyk, S. A., & Proulx, D. (2023). Supply chain deep uncertainties and risks: The 'new normal.' In *Supply chain risk and disruption management: Latest tools, techniques, and management approaches* (pp. 51–72). Springer Nature Singapore. https://link.springer.com/chapter/10.1007/978-981-99-2629-9_3

Ganesh, A. D., & Kalpana, P. (2022). Future of artificial intelligence and its influence on supply chain risk management—A systematic review. *Computers & Industrial Engineering, 169*, 108206. https://doi.org/10.1016/j.cie.2022.108206

Gereffi, G., Lim, H. C., & Lee, J. (2021). Trade policies, firm strategies, and adaptive reconfigurations of global value chains. *Journal of International Business Policy, 4*(4), 506. https://pmc.ncbi.nlm.nih.gov/articles/PMC7961166/

Ghobakhloo, M., Iranmanesh, M., Foroughi, B., Tirkolaee, E. B., Asadi, S., & Amran, A. (2023). Industry 5.0 implications for inclusive sustainable manufacturing: An evidence-knowledge-based strategic roadmap. *Journal of Cleaner Production, 417*, Article 138023. https://doi.org/10.1016/j.jclepro.2023.138023

Grossman, G. M., Helpman, E., & Lhuillier, H. (2023). Supply chain resilience: Should policy promote international diversification or reshoring? *Journal of Political Economy, 131*(12), 3462–3496. https://www.journals.uchicago.edu/doi/abs/10.1086/725173

Guerra, J. H. L., Bernardi de Souza, F., Pires, S. R., Salgado, M. H., & Sá, A. L. R. D. (2024). Supply chain risk management (SCRM) process: An analysis in the aerospace industry. *Benchmarking: An International Journal*. https://www.emerald.com/insight/content/doi/10.1108/bij-12-2023-0844/full/html

Gupta, A. K., & Srivastava, M. K. (2024). Framework for AI adoption in the health care sector: Integrated DELPHI, ISM-MICMAC approach. *IEEE Transactions on Engineering Management*. https://doi.org/10.1109/TEM.2024.10495137

Hariram, N. P., Mekha, K. B., Suganthan, V., & Sudhakar, K. (2023). Sustainalism: An integrated socio-economic-environmental model to address sustainable development and sustainability. *Sustainability, 15*(13), Article 10682. https://www.mdpi.com/2071-1050/15/13/10682

Harmanci, H. (2025). Navigating Turbulent Waters in the US-China Trade War and the Role of BRICS in Shaping Global Dynamics. In A. Gedikli, S. Erdogan, & H. Çalışkan Terzioğlu (Eds.), *Changing the Global Political Economy: BRICS Countries and Alternative Relations Strategies* (pp. 237-274). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-7393-4.ch008

Howick, S., & Megiddo, I. (2024). A framework for conceptualizing hybrid system dynamics and agent-based simulation models. *European Journal of Operational Research, 315*(3), 1153–1166. https://www.sciencedirect.com/science/article/pii/S0377221724000468

Jazairy, A., Brho, M., Manuj, I., & Goldsby, T. J. (2024). Cyber risk management strategies and integration: Toward supply chain cyber resilience and robustness. *International Journal of Physical Distribution & Logistics Management, 54*(11), 1–29. https://www.emerald.com/insight/content/doi/10.1108/ijpdlm-12-2023-0445/full/html

Jena, R. K. (2025). Factors influencing blockchain adoption in accounting and auditing in the face of Industry 4.0: A multi-criteria decision-making approach. *Journal of Accounting & Organizational Change*. Advance online publication. https://doi.org/10.1108/jaoc-11-2023-0205

Jidda Jidda, D., Zhen, L., Ashraf, S. F., Nasir, A., & Amoako, T. (2025). Value of enterprise risk management integration and supply chain performance: Mediating role of firm's resilience capability. *SAGE Open, 15*(1), 21582440241305618. https://doi.org/10.1177/21582440241305618

Kamalahmadi, M., Shekarian, M., & Mellat Parast, M. (2022). The impact of flexibility and redundancy on improving supply chain resilience to disruptions. *International Journal of Production Research, 60*(6), 1992–2020. https://doi.org/10.1080/00207543.2021.1883759

Koller, Y., Holota, N., Yastrubetskyi, V., Saienko, V., & Bulgakova, I. (2022). Transport and logistics security: Implementation of EU and US rights. *AD ALTA: Journal of Interdisciplinary Research, 12*(Special Issue 02-XXXI), 52–57. https://www.researchgate.net/publication/368662790_TRANSPORT_AND_LOGISTICS_SECURITY_IMPLEMENTATION_OF_EU_AND_US_RIGHTS

Kosasih, E. E., Papadakis, E., Baryannis, G., & Brintrup, A. (2024). A review of explainable artificial intelligence in supply chain management using neurosymbolic approaches. *International Journal of Production Research, 62*(4), 1510–1540. https://www.tandfonline.com/doi/full/10.1080/00207543.2023.2281663

Kuguoglu, B. K., van der Voort, H., & Janssen, M. (2021). The giant leap for smart cities: Scaling up smart city artificial intelligence of things (AIOT) initiatives. *Sustainability, 13*(21), 12295. https://www.mdpi.com/2071-1050/13/21/12295

Liu, Y. D., Zhang, J. Z., Zheng, J., & Kamal, M. M. (2025). Artificial intelligence-enabled systems and innovation in B2B firms: The role of strategic agility and decision-making performance. *Industrial Marketing Management, 127*, 164–174. https://doi.org/10.1016/j.indmarman.2025.02.007

Maddodi, S., & Kunte, S. R. (2024). Market resilience in turbulent times: A proactive approach to predicting stock market responses during geopolitical tensions. *Journal of Capital Markets Studies, 8*(2), 173–194. https://doi.org/10.1108/jcms-12-2023-0049

Mahanti, R. (2021). Data and its governance. In *Data governance and data management: Contextualizing data governance drivers, technologies, and tools* (pp. 5–82). Springer Singapore. https://link.springer.com/chapter/10.1007/978-981-16-3583-0_2

Mazumdar, S. (2024). How does culture influence design? In *Theorizing built form and culture* (pp. 265–279). Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781003372110-25/culture-influence-design-sanjoy-mazumdar

Mendoza, A., & Villafuerte, J. (2023). The state of play of ASEAN global value chains. In *ASEAN and global value chains* (p. 44). Asian Development Bank. https://www.adb.org/sites/default/files/publication/871976/asean-global-value-chains-resilience-sustainability.pdf#page=66

Mistarihi, M. Z., & Magableh, G. M. (2023). Unveiling supply chain nervousness: A strategic framework for disruption management under a fuzzy environment. *Sustainability, 15*(14), 11179. https://www.mdpi.com/2071-1050/15/14/11179

Möller, D. P. (2023). Ransomware attacks and scenarios: Cost factors and loss of reputation. In *Guide to cybersecurity in digital transformation: Trends, methods, technologies, applications, and best practices* (pp. 273–303). Springer Nature Switzerland. https://link.springer.com/chapter/10.1007/978-3-031-26845-8_6

Moloi, T., & Marwala, T. (2023). The concept of enterprise risk management. In *Enterprise risk management in the fourth industrial revolution* (pp. 35–48). Springer Nature Singapore. https://link.springer.com/chapter/10.1007/978-981-99-6307-2_4

Namozov, J., Arabov, N., Aduramanov, X., Nasimov, D., Makhmudova, M., & Ibragimov, L. (2024). Dynamics of transformation and economic resilience in agricultural lands: An anthropogenic perspective. In *E3S Web of Conferences* (Vol. 541, p. 03003). EDP Sciences. https://doi.org/10.1051/e3sconf/202454103003

Nguyen, H., Pham, A. V., Pham, M. D. M., & Pham, M. H. (2023). Business resilience: Lessons from government responses to the global COVID-19 crisis. *International Business Review, 32*(5), 102166. https://doi.org/10.1016/j.ibusrev.2023.102166

Nguyen, T. T. H. (2024). Measuring supply chain performance using the SCOR Model. *Operations Research Forum, 5*(2), Article 37. https://doi.org/10.1007/s43069-024-00314-y

Nicola-Gavrilă L., Omarova, A., Kurmanalina, A., & Kalkabayeva, G. (2025). The Role of Good Governance Networking in Enhancing Organizational Performance and Logistics Systems: Insights for Distribution Economics. *Journal of Distribution Science*, 23(5), 1–11. https://doi.org/10.15722/JDS.23.05.202505.1

Nicoletti, B. (2023). SCOR Model. In *Supply network 5.0: How to improve human automation in the supply chain* (pp. 19–41). Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-031-22032-6_2

Nitsche, B., Brands, J., Treiblmaier, H., & Gebhardt, J. (2023). The impact of multiagent systems on autonomous production and supply chain networks: Use cases, barriers, and contributions to logistics network resilience. *Supply Chain Management: An International Journal, 28*(5), 894–908. https://www.igi-global.com/chapter/navigating-turbulent-waters-in-the-us-china-trade-war-and-the-role-of-brics-in-shaping-global-dynamics/365245

Orlov, O., Dumanska, K., Ponomaryova, N., & Kobets, D. (2020). Company's strategic success as the basis of its potential sustainability. In *E3S Web of Conferences*, Volume 166, p. 12002. EDP Sciences. https://doi.org/10.1051/e3sconf/202016612002

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372,* n71. https://www.bmj.com/content/372/bmj.n71.short

Pal, T., Bommisetti, V., Suvarnakanti, P., Dudala, S. S., Asha, S., & Jaiswal, V. (2025). The revolutionary role of blockchain technology in the agri-food sector focusing on the food supply chain. *Food Reviews International, 41*(3), 770–801. https://www.tandfonline.com/doi/abs/10.1080/87559129.2024.2418464

Patel, N. R. (2025). Supply chain management in the digital age for Industry 4.0. In *Industry 4.0, smart manufacturing, and industrial engineering*, 179–195. CRC Press. https://www.taylorfrancis.com/chapters/edit/10.1201/9781003473886-9/supply-chain-management-digital-age-industry-4-0-nikunj-patel

Potwora, M., Zakryzhevska, I., Mostova, A., Kyrkovskyi, V., & Saienko, V. (2023). Marketing strategies in e-commerce: Personalized content, recommendations, and increased customer trust. *Financial and Credit Activity: Problems of Theory and Practice, 5*(52), 562–573. https://doi.org/10.55643/fcaptp.5.52.2023.4190

Pryimak, M., Kalyta, L., Sokolov, M., Vladyslav, K., & Krasnykov, Y. (2024). Innovative approaches to risk management in the field of public administration in Ukraine: Prospects and limitations. *Revista Amazonia Investiga, 13*(74), 308–322. https://doi.org/10.34069/AI/2024.74.02.26

Pu, G., Li, S., & Bai, J. (2023). Effect of supply chain resilience on a firm's sustainable competitive advantage: A dynamic capability perspective. *Environmental Science and Pollution Research, 30*(2), 4881–4898. https://link.springer.com/article/10.1007/s11356-022-22483-1

Rasulov, R. (2024). Economic substantiation of innovative solutions for direct cooperation between manufacturers and restaurants. *Futurity Economics & Law, 4*(4), 121–136. https://doi.org/10.57125/FEL.2024.12.25.07

Rauniyar, K., Wu, X., Gupta, S., Modgil, S., & Lopes de Sousa Jabbour, A. B. (2023). Risk management of supply chains in the digital transformation era: Contribution and challenges of blockchain technology. *Industrial Management & Data Systems, 123*(1), 253–277. https://www.emerald.com/insight/content/doi/10.1108/imds-04-2021-0235/full/html

Rejeb, A., Keogh, J. G., Simske, S. J., Stafford, T., & Treiblmaier, H. (2021). Potentials of blockchain technologies for supply chain collaboration: A conceptual framework. *The International Journal of Logistics Management, 32*(3), 973–994. https://www.emerald.com/insight/content/doi/10.1108/ijlm-02-2020-0098/full/html

Roieva, O., Oneshko, S., Sulima, N., Saienko, V., & Makurin, A. (2023). Identification of digitalization as a direction of innovative development of modern enterprise. *Financial & Credit Activity: Problems of Theory & Practice, 1*(48), 312–325. https://doi.org/10.55643/fcaptp.1.48.2023.3968

Rosário, A. T., & Dias, J. C. (2023). How Industry 4.0 and sensors can leverage product design: Opportunities and challenges. *Sensors, 23*(3), 1165. https://www.mdpi.com/1424-8220/23/3/1165

Shah, S. S., & Asghar, Z. (2023). Dynamics of social influence on consumption choices: A social network representation. *Heliyon, 9*(6), e17873. https://www.cell.com/heliyon/fulltext/S2405-8440(23)04354-2

Shah, S. S., & Shah, S. A. H. (2024). Trust as a determinant of social welfare in the digital economy. *Social Network Analysis and Mining, 14*(1), 79. https://link.springer.com/article/10.1007/s13278-024-01238-5

Shah, S. S. (2024). The influence of internet-derived misinformation on medical treatment decisions: A social learning perspective. *Journal of Public Health, 1*, 100005. https://premierscience.com/wp-content/uploads/2024/10/pjph-24-353.pdf

Shamsuddoha, M., & Nasir, T. (2023). Principal lessons learned from COVID-19: Prescriptive and long-lasting strategies for sustainable supply chain improvement. In *Advanced technologies and the management of disruptive supply chains: The post-COVID era* (pp. 81–105). Springer Nature Switzerland. https://link.springer.com/chapter/10.1007/978-3-031-45229-1_5

Soumpenioti, V., & Panagopoulos, A. (2023). AI technology in the field of logistics. In *2023 18th International Workshop on Semantic and Social Media Adaptation & Personalization (SMAP 2023)* (pp. 1–6). IEEE. https://ieeexplore.ieee.org/abstract/document/10255203

Takefuji, Y. (2023). Security enhancement of third parties is needed in global supply chain management. *Journal of Applied Security Research, 18*(4), 766–773. https://www.tandfonline.com/doi/abs/10.1080/19361610.2022.2086785

Thakur-Weigold, B., & Miroudot, S. (2024). Supply chain myths in the resilience and deglobalization narrative: Consequences for policy. *Journal of International Business Policy, 7*(1), 99–111. https://link.springer.com/article/10.1057/s42214-023-00170-3

Tretiak, O. A., Khmelnykov, A. O., Batrymenko, V., Karashchuk, M., & Husieva, N. (2024). Paradigmatic dimensions of local public management research: The path to reliable managerial decisions. *Revista Amazonia Investiga, 13*(76), 228–235. https://doi.org/10.34069/AI/2024.76.04.18

Vasylieva, N. (2021). Food security in times of Covid-19: Price aspects in Ukraine and neighbouring EU countries. *Montenegrin Journal of Economics, 17*(3), 21–30. https://doi.org/10.14254/1800-5845/2021.17-3.2

Vital-Soto, A., & Olivares-Aguila, J. (2023). Manufacturing systems for unexpected events: An exploratory review for operational and disruption risks. *IEEE Access, 11*, 96297–96316. https://doi.org/10.1109/ACCESS.2023.10237110

Wicaksana, A., Ho, W., Talluri, S., & Dolgui, A. (2022). A decade of progress in supply chain risk management: Risk typology, emerging topics, and research collaborators. *International Journal of Production Research, 60*(24), 7155–7177. https://www.tandfonline.com/doi/abs/10.1080/00207543.2022.2077672

Wieland, A., & Durach, C. F. (2021). Two perspectives on supply chain resilience. *Journal of Business Logistics, 42*(3), 315–322. https://doi.org/10.1111/jbl.12271

Yang, C., & Chan, D. Y. T. (2023). Geopolitical risks of strategic decoupling and recoupling in the mobile phone production shift from China to Vietnam: Evidence from the Sino-US trade war and COVID-19 pandemic. *Applied Geography, 158*, 103028. https://www.sciencedirect.com/science/article/abs/pii/S0143622823001595

Yun, N. Y., & Ülkü, M. A. (2023). Sustainable supply chain risk management in a climate-changed world: Review of extant literature, trend analysis, and guiding framework for future research. *Sustainability, 15*(17), 13199. https://www.mdpi.com/2071-1050/15/17/13199

Zavhorodnii, A., Ohiienko, M., Biletska, Y., Bondarenko, S., Duiunova, T., & Bodenchuk, L. (2021). Digitalization of agribusiness in the development of foreign economic relations of the region. *Journal of Information Technology Management*, 13(Special Issue: Advanced Innovation Topics in Business and Management), 123–141. https://jitm.ut.ac.ir/article_82613.html

Zheng, L. J., Islam, N., Zhang, J. Z., Behl, A., Wang, X., & Papadopoulos, T. (2025). Aligning risk and value creation: A process model of supply chain risk management in geopolitical disruptions. *International Journal of Operations & Production Management, 45*(5), 1178–1210. https://www.emerald.com/insight/content/doi/10.1108/ijopm-03-2024-0271/full/html