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Operational Risk Management in an Unstable Global Supply Chain

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***Abstract*:** *Global supply chain instability driven by geopolitical volatility, climate-related disruptions, energy crises, and logistical bottlenecks has intensified operational risks across industries. This study aims to analyze key sources of operational risk and identify effective mitigation strategies using a Systematic Literature Review (SLR). The SLR process involved the identification, screening, eligibility assessment, and thematic analysis of 26 relevant peer-reviewed publications from the last decade. The findings reveal that operational risks originate from supplier fragility, geographic dependency, macroeconomic uncertainty, climate-related hazards, and technological vulnerabilities. Mitigation strategies identified include supplier diversification, inventory optimization, digital visibility systems, production regionalization, scenario modeling, and inter-organizational risk collaboration. The study also finds that an integrated risk management model such as incorporating digital early-warning systems, rapid response capabilities, long-term adaptive capacity, and strategic collaboration, offers the most effective approach to enhancing global supply chain resilience. It concludes that firms must strengthen technological integration and organizational capacity to respond adaptively to disruptions, while public-policy support is essential to reinforce logistics infrastructure and digitalization, particularly in developing economies.*

Keywords : adaptation, global supply chains, operational resilience, risk management, supply chain digitalization.

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INTRODUCTION

Global supply chain instability has become a major concern for companies around the world, especially in the wake of the COVID-19 pandemic, geopolitical conflicts, energy crises, and climate change, which have affected the flow of raw materials, logistics costs, and the reliability of goods distribution. Over the past decade, operational risks have increased sharply as the world economy has become more deeply integrated, meaning that disruptions in one region can quickly spread throughout the global production network. According to a report by the McKinsey Global Institute (2023), more than 80% of multinational companies have experienced at least one major supply chain disruption in the past five years, with the average duration of the disruption reaching 3-6 months. These disruptions stem from various sources, including electronic component shortages, international port congestion, energy price fluctuations, and inter-country trade restrictions. This shows that supply chains traditionally designed for efficiency now face an urgent need to strengthen their resilience and operational risk mitigation capabilities.

The instability of global supply chains is increasingly influenced by uncertain geopolitical conditions. The Russia Ukraine conflict, for example, has led to increases in global energy and commodity prices and disruptions in the distribution of strategic raw materials such as nickel, gas, and wheat. The OECD (2023) reports that the war has increased the global supply chain risk index by 27% in the last two years, particularly in the energy, heavy manufacturing, and logistics sectors. Tensions between the United States and China have also triggered drastic changes in goods distribution channels and technology export policies, causing global companies to review their supply chain structures to reduce dependence on a single country or trade route. In this context, companies need to develop smarter and more adaptive operational risk management strategies to mitigate the impact of sudden geopolitical disruptions.

In addition to geopolitical factors, climate change has become a major new cause of global supply chain instability. Environmental disasters such as floods, storms, extreme droughts, and heat waves can affect transportation operations, raw material availability, and production capacity in various countries. The United Nations Environment Programme (2022) notes that climate disasters cause global economic losses of more than USD 320 billion per year, mostly from disruptions to operations and distribution of goods. The agriculture, energy, textile, and manufacturing sectors are the most vulnerable to these disruptions. Under these conditions, companies need to integrate climate risk analysis into their operational risk management frameworks, including facility location mapping, supplier diversification, and disaster recovery strategies.

In Asia, including Indonesia, global supply chains are also under pressure due to logistics cost volatility and dependence on raw material imports. The World Bank (2023) reports that container shipping costs from Asia to the Americas and Europe increased by up to 500% during the 2021–2022 logistics crisis, and although they have declined, price uncertainty remains high. Indonesia, as an importer of electronic components, chemicals, and key industrial products, is directly affected by these fluctuations. The Central Statistics Agency (2023) shows that more than 35% of Indonesian manufacturing industries have experienced disruptions in the supply of imported raw materials in the last two years, mainly due to delivery delays and increased logistics costs. This condition confirms that dependence on long and fragmented global supply chains makes Indonesian companies vulnerable to increasingly complex operational risks.

In operations management and supply chain management studies, operational risk encompasses all risks that disrupt the flow of goods, information, and production processes in the supply chain system (Um & Han, 2021). These risks include supplier failure, logistical

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delays, technological disruptions, human error, and internal process failures throughout the supply chain. Operational risk theory emphasizes the importance of a company's ability to identify risks, predict impacts, and design appropriate mitigation strategies. Chen et al. (2022) explain that the higher the global integration of a supply chain, the higher the level of operational failure risk due to interdependence between nodes in the supply network. Thus, companies must not only understand risks originating from within, but also external risks that are beyond the company's direct control.

International studies show that supply chain operational risks can have a major impact on company performance, in terms of decreased productivity, increased production costs, and lost market opportunities. Johnson & Haug (2021) found in their study that post-pandemic global supply chain disruptions caused a 28% decline in production capacity in the global automotive and electronics sectors due to semiconductor supply constraints. Meanwhile, research by Elliott et al. (2022) shows that companies that do not have a strong operational risk management strategy tend to experience slower recovery after major disruptions. In the Indonesian context, a study by Akbar & Isfianadewi (2023) confirms that companies with proactive risk management strategies can reduce logistics costs by up to 18% through supplier diversification and supply chain monitoring digitalization.

However, there are a number of important research gaps that need to be analyzed to strengthen the understanding of operational risk management in global supply chains. First, the study "Modifications to global supply chain management strategies resulting from recent trade disruptions: an exploratory study" by Johnson & Haug (2021) focuses on multinational companies, but has not examined the adaptation of medium-sized companies in developing countries such as Indonesia, which have limited resources to implement risk mitigation technologies. Second, the study "Transportation research Part E-logistics and transportation review: 25 years in retrospect" by Chen et al. (2022) emphasizes structural risk factors, but has not integrated climate risk and environmental disaster variables, which are now increasingly affecting global supply chains. Third, the study "Supplier Fragility and Network Vulnerability" by Elliott et al. (2022) discusses supplier vulnerability in global network structures, but has not yet reviewed in depth the role of digitalization in strengthening real-time risk detection. These three gaps underscore the need for comprehensive research that integrates geopolitical, climate, and digitalization risk factors into corporate operational risk management strategies in global and regional contexts.

The novelty of this research lies in its approach of integrating three sources of global supply chain instability such as geopolitics, climate change, and digital transformation, into an operational risk management framework, as well as highlighting its relevance to companies in Indonesia as a developing country with high supply chain dependence. In addition, this study combines global and regional empirical findings through the SLR method, resulting in a more comprehensive and relevant risk mapping for modern management practices. With an approach that combines operational risk theory, global supply chain dynamics, and digital technology, this study provides a broader conceptual contribution to the literature on risk management and supply chain resilience.

The purpose of this study is to analyze the main operational risks in unstable global supply chains, identify the triggering factors, and evaluate the most effective risk mitigation strategies based on scientific findings from the past decade. This study also aims to provide recommendations for companies in Indonesia to build supply chain resilience through supply source diversification, operational monitoring digitalization, and strengthening strategic risk management in line with the global and domestic contexts.

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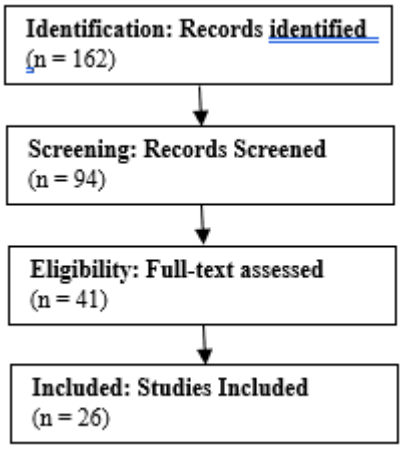
METHOD

This study uses the Systematic Literature Review (SLR) method to comprehensively examine operational risks in the global supply chain and their mitigation strategies based on scientific publications from the last decade. The SLR method was chosen because it allows for a systematic, transparent, and structured literature review process that is able to identify trends, patterns, and research gaps more objectively (Snyder, 2019). This approach is considered most relevant given that the topic of global supply chains involves complex variables spread across various disciplines such as operations management, international logistics, global economics, and risk management. Thus, SLR provides a robust methodological framework for synthesizing various empirical and conceptual findings into a single integrated analysis.

The research process began with the identification of literature through searches in reputable international databases, including Scopus, ScienceDirect, Taylor & Francis, SpringerLink, and Google Scholar. The keywords used included "operational risk," "global supply chain instability," "supply chain resilience," "risk mitigation strategies," and "disruption management." The literature search was limited to publications from 2014 to 2024 to ensure relevance to the latest dynamics of global supply chains, which have changed dramatically in the last decade (Xiao & Watson, 2019). Inclusion criteria included peer-reviewed scientific articles, academic books, international agency reports, and empirical studies discussing operational risk, supply chain disruption, or mitigation strategies. Literature that was irrelevant, had not undergone a peer review process, or consisted solely of opinions without a methodological basis was excluded from the analysis.

The screening stage was conducted by reviewing titles, abstracts, and keywords to ensure relevance to the research focus. Relevant articles were then analyzed for suitability by reviewing their full content, methodological quality, and contribution to the understanding of supply chain operational risks. Eligible literature was analyzed using a thematic analysis approach (Braun & Clarke, 2021) to identify key patterns such as sources of risk, supply chain network vulnerabilities, the role of digitalization in risk mitigation, and organizational adaptation strategies. This analytical approach allows for the systematic grouping of findings so that they can be linked to operational risk management theory and global supply chain dynamics.



RESULTS AND DISCUSSION

Sources of Operational Risk in an Unstable Global Supply Chain

Over the past decade, the global supply chain has experienced unprecedented levels of instability, marked by a combination of geopolitical pressures, global health crises, climate change, economic volatility, and technological disruption. This instability increases companies' exposure to operational risks, which are risks arising from internal process failures, external disruptions, or systemic inefficiencies in the flow of goods, information, and finance. In supply chain management literature, operational risk is considered one of the most critical risks because it can lead to production disruptions, cost surges, and sudden market losses (Chen et al., 2022). To understand this risk more deeply, it is important to unravel the main factors that are sources of instability in the contemporary global supply chain.

One of the biggest sources of risk stems from the fragility of global suppliers. Increasingly deep international economic integration has led companies to become highly dependent on supplier networks spread across multiple countries. Dependence on a

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single supplier or suppliers from the same geographical region increases the risk of disruption in the event of external shocks. A study by Johnson & Haug (2021) shows that the global semiconductor crisis that began in 2020 had a domino effect on the automotive, electronics, and energy industries, as most components are produced by a few large suppliers in East Asia. This vulnerability indicates that long and fragmented supply chain structures increase the risk of operational failure when suppliers face production or logistical obstacles. Even for companies with long-term contracts, supply uncertainty remains difficult to avoid due to external factors such as lockdown policies, export restrictions, or sudden production facility closures.

In addition to supplier fragility, geopolitical volatility is a source of widespread operational risk. The Russia-Ukraine conflict, for example, has caused disruptions to the supply of energy and strategic commodities worldwide. The OECD (2023) notes that the war has increased global supply chain uncertainty by 27%, particularly in the energy, logistics, and heavy manufacturing sectors. Tensions between the United States and China also affect the stability of global supply chains through technology export restrictions, import tariffs, and the fragmentation of international logistics networks. Global companies must adjust their supply structures to reduce dependence on high-risk regions, often through geographic diversification or partial relocation of production. However, these mitigation strategies require significant investment and lengthy implementation times, meaning that operational risk remains a critical issue in the short term.

Another important risk factor is macroeconomic volatility. Changes in commodity prices, global interest rate hikes, inflation, and exchange rate fluctuations can significantly affect production and procurement costs. The International Monetary Fund (2023) reports that global economic uncertainty in the 2021–2023 period is at one of its highest points in the last two decades due to uneven post-pandemic recovery, the energy crisis, and global inflationary pressures. For companies, this volatility can lead to increased operating costs, decreased demand, and the risk of supplier failure due to financial constraints. In the context of global supply chains, macroeconomic fluctuations can cause sudden changes in demand patterns, production capacity, and logistics availability, adding pressure to operational stability.

Climate change is also an increasingly relevant source of critical risk. Natural disasters such as floods, major storms, droughts, and heat waves can cause port closures, transportation disruptions, and damage to production facilities. The United Nations Environment Programme (2022) asserts that climate disasters cause more than USD 320 billion in global economic losses each year, with most losses related to supply chain and business operation disruptions. In some cases, natural disasters cause supply delays lasting weeks or even months. Companies in the agriculture, textile, and energy sectors are particularly vulnerable to climate change due to their dependence on natural resources and specific production locations. Therefore, companies need to integrate climate risk into their operational risk mitigation strategies to reduce potential long-term losses.

In addition to external factors, operational risks also stem from internal company factors. Complex production processes, inefficient inventory management systems, reliance on vulnerable technology, or human error can increase supply chain vulnerability. Chen et al. (2022) emphasize that internal operational risks are often the main cause of minor disruptions that can accumulate into major failures in the long term. For example, IT system failures can hamper ordering, inventory recording, and shipping processes, creating disruptions at critical points in the supply chain. In addition, a lack of employee training or interdepartmental coordination can also slow down the company's response to market changes or external disruptions.

In the digital age, technology-related internal risks have become increasingly important to consider, especially with the rise

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of cyber security threats that can disable systems in a short period of time. Digital technology plays a dual role in global supply chain operational risk. On the one hand, technology offers opportunities to improve efficiency, visibility, and risk control through big data analytics, the Internet of Things (IoT), and artificial intelligence.

However, on the other hand, technology also introduces new risks such as cyber attacks, hardware or software system failures, and over-reliance on digital systems. The McKinsey Global Institute (2022) reports that 45% of global companies have experienced technology-related operational disruptions at least once in the past two years, particularly in the logistics and manufacturing sectors. Ransomware attacks, for example, can lock a company's ERP system, halt production operations, and hamper the distribution of goods. Therefore, companies must balance the benefits of digitization with investments in IT system security and resilience.

In the context of developing countries such as Indonesia, sources of operational risk have specific characteristics that differ from those in developed countries. Indonesia faces challenges in the form of high dependence on imported raw materials, suboptimal logistics infrastructure, and uneven technological capacity among companies. The Central Statistics Agency (2023) noted that 35% of manufacturing companies experienced delays in imported raw material supplies in the last two years, caused by international shipping barriers and increased logistics costs. In addition, many small and medium-sized companies have not yet adopted adequate digital technology to effectively support operational risk management. This makes companies more vulnerable to external and internal disruptions that affect production and distribution flows.

Apart from structural problems, operational risks in developing countries are also influenced by regulatory uncertainty, weak inter-agency coordination, and a lack of risk management capacity at the company level. Akbar & Isfianadewi (2023) found that companies that do not have a dedicated risk management team tend to react more slowly to supply chain disruptions and have higher cost losses.

This condition shows that operational risk management is not only a technical issue, but also related to institutional capacity and human resource readiness within the company. Overall, the SLR conducted shows that the sources of operational risk in the global supply chain originate from a combination of external and internal factors that reinforce each other.

The fragility of global suppliers, geopolitical volatility, climate change, and macroeconomic uncertainty increase companies' exposure to operational disruptions. On the other hand, internal capacity constraints, process failures, and technological risks further exacerbate companies' vulnerability. By understanding these sources of risk holistically, companies can develop more comprehensive mitigation strategies and build supply chain resilience in the face of global instability.

Operational Risk Mitigation Strategies in the Global Supply Chain: An Adaptive and Technology-Based Approach

In the face of global supply chain instability, companies need to implement comprehensive, adaptive, and long-term operational risk mitigation strategies. As risk sources become increasingly complex (ranging from supplier disruptions, geopolitical volatility, climate risks, to technological vulnerabilities) mitigation strategies can no longer rely solely on traditional approaches. Companies must build integrated risk management systems, use data as a basis for decision-making, and equip the supply chain with digital technologies that strengthen visibility and operational responsiveness. Johnson & Haug (2021) show that companies with mitigation strategies based on structural and technological adaptation have proven to recover more quickly from global supply disruptions in the post-pandemic era. Thus, risk mitigation strategies aim not only to prevent losses, but also to increase supply chain resilience and long-term competitiveness.

One of the most widely recommended mitigation strategies in the literature is supplier diversification. Dependence on a single

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supplier or production region can be a major cause of disruption in the event of a disaster, political conflict, or economic instability. The OECD (2023) asserts that companies that diversify their suppliers across at least two different regions have a 40% lower risk of supply failure than companies with a centralized supplier structure. Diversification not only involves increasing the number of suppliers, but also a multi-sourcing strategy that separates strategic suppliers from complementary suppliers, giving companies flexibility when demand increases or supply disruptions occur. However, this strategy requires greater costs and coordination because companies must manage relationships with more suppliers while ensuring consistent quality standards.

In addition to supplier diversification, companies also implement buffer stock to cope with demand fluctuations and supply disruptions. This strategy has proven effective in industries with critical components, such as automotive and electronics. However, buffer stock carries additional risks in the form of high storage costs and potential inventory depreciation. Therefore, companies must balance cost efficiency and supply resilience through data-driven inventory optimization. Chen et al. (2022) assert that conventional inventory management is no longer effective in the face of global instability; companies must adopt machine learning-based demand forecasting algorithms to ensure that inventory remains optimal.

Modern mitigation strategies emphasize the importance of end-to-end supply chain visibility, which is the ability of companies to monitor the entire supply chain from the supplier to the consumer. Digital technologies such as the Internet of Things (IoT), blockchain, and real-time tracking systems enable companies to obtain accurate and fast operational data. The McKinsey Global Institute (2022) shows that companies that implement real-time visibility systems are three times faster at detecting disruptions and reallocating resources than companies that still use manual systems. This visibility provides a strategic advantage because companies can identify potential risks long before they significantly disrupt operations.

To illustrate commonly used risk mitigation strategies, the following table is presented. This table is compiled based on a synthesis of literature and is presented in English to maintain consistency with international scientific publication standards. The table summarizes the main strategies, key characteristics, and strategic benefits.

Table 1. Key Operational Risk Mitigation Strategies in Global Supply Chains.

Strategy Type	Key Characteristics	Strategic Benefits
Supplier Diversification	Multi-sourcing, multi-region suppliers	Reduces dependency risks and improves supply continuity
Inventory Buffering	Safety stock, demand forecasting algorithms	Minimizes disruption impact and stabilizes production cycles
Digital Visibility Systems	IoT tracking, blockchain records, real-time monitoring	Enhances early risk detection and accelerates decision-making
Nearshoring & Reshoring	Relocating production closer to demand markets	Shortens lead time and reduces geopolitical exposure
Collaborative Risk-Sharing	Strategic alliances, shared platforms, integrated planning	Strengthens resilience through shared resources and coordination

The table shows that operational risk mitigation strategies are multidimensional and complementary. Supplier diversification

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provides structural resilience; buffer inventory provides operational resilience; while visibility technology provides informational resilience. These three dimensions interact to strengthen the overall resilience of the global supply chain.

In addition to technical strategies, companies also implement localization and regionalization strategies, which involve shifting some operations or suppliers to areas closer to the market. These strategies are called nearshoring or reshoring and have been widely used since the pandemic. The OECD (2023) notes a trend of increased new investment in Southeast Asia as a form of production diversification from China. By reducing dependence on a single country or logistics route, companies can lower geopolitical risks and speed up delivery times. However, this strategy requires significant investment in infrastructure and technological adaptation.

Another mitigation strategy is inter-company risk collaboration. Collaboration is carried out through strategic alliances, shared data platforms, or integrated planning systems between companies and key suppliers. Elliott et al. (2022) show that companies that collaborate closely with suppliers have more stable performance and lower disruption rates. Collaboration enables rapid exchange of risk information, coordination of planning, and resolution of disruptions through resource-sharing schemes. In the logistics sector, for example, companies can share transportation capacity or storage facilities when demand increases.

Companies also strengthen risk mitigation through scenario modeling and stress testing, which are simulations to identify how the supply chain responds to various extreme disruptions. Using big data and network modeling, companies can predict critical vulnerabilities in the supply chain and prepare rapid response strategies. Johnson & Haug (2021) prove that companies that routinely conduct stress testing have higher resilience when facing sudden disruptions such as port closures or electronic component crises.

Finally, companies need to build adaptive organizational structures, including the formation of dedicated risk management teams and the implementation of rapid response units. Akbar & Isfianadewi (2023) emphasize that companies with trained risk management units have mitigation capabilities up to 30% faster than companies without formal risk structures.

Overall, operational risk mitigation strategies in global supply chains must be integrated, combining structural, technological, collaborative, and organizational approaches. Companies that are able to adopt a combination of these strategies are proven to be better prepared to face global instability and recover more quickly when disruptions occur.

Integrated Risk Management Models and Strategic Implications for Global Supply Chain Resilience

Operational risk management in global supply chains cannot be understood as a series of stand-alone actions. Instead, the various mitigation strategies discussed in the previous subsection will only be effective if they are integrated into a comprehensive, adaptive, and long-term risk management model. This integrated model includes a combination of early detection systems, rapid response, adaptability, structural diversification, and strong risk governance at the organizational level. Recent literature shows that companies that are able to integrate technological approaches, collaboration, organizational structures, and operational strategies have higher supply chain resilience than companies that implement strategies partially (Johnson & Haug, 2021). Thus, the establishment of an integrated risk management model is key to addressing global supply chain instability.

An integrated risk management model begins with holistic risk mapping, which includes identifying internal and external risks through historical analysis, global environmental scanning, and the use of big data to predict potential disruptions. The McKinsey Global Institute (2022) shows that companies using data-based risk mapping models are able to identify potential disruptions up to 45% faster than companies

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using conventional methods. This risk mapping not only focuses on suppliers but also takes into account geopolitical risks, macroeconomic volatility, climate change, and technological risks. By understanding the relationship between these various risks, companies can develop preventive strategies that are more effective and relevant to the dynamics of the environment.

The next component in the integrated risk management model is a digital-based early warning system. Technologies such as the Internet of Things (IoT), blockchain, and real-time monitoring systems play an important role in detecting operational deviations before they become major disruptions. Such systems provide rapid notifications when there are delivery delays, changes in demand patterns, or fluctuations in supplier capacity. Chen et al. (2022) emphasize that early detection is a fundamental element in reducing operational risk because it allows companies to take corrective action before losses spread throughout the supply chain network. Thus, investment in technological infrastructure for early detection is an important part of a modern risk management model.

The third aspect of an integrated model is rapid response capability, which is a company's ability to quickly reallocate resources, adjust production processes, and activate emergency protocols when disruptions occur. Romero et al (2024) explains that companies with flexible organizational structures tend to have faster responses because decision-making can be decentralized. In the context of global supply chains, rapid response may involve diverting orders to alternative suppliers, activating backup logistics channels, or adjusting production capacity. Companies that have rapid response units and standard operating procedures for crises have proven to be better able to mitigate the impact of disruptions than companies that do not have a formal response structure (Akbar & Isfianadewi, 2023). This rapid response is becoming increasingly important in conditions of global uncertainty because disruptions can spread quickly through international logistics networks.

In addition to rapid response, an integrated risk management model also requires long-term adaptive capacity, which includes organizational learning, innovation, and strategic restructuring. Kaur (2023) describes this capacity as a company's ability to integrate sensing, seizing, and reconfiguring capabilities in the face of uncertainty. In the context of global supply chains, adaptive capacity enables companies to redesign supplier networks, invest in new technologies, or develop alternative business models when major disruptions occur. Adim & Unaam (2022) show that companies with high adaptive capabilities are able to recover more quickly from global crises because they have flexibility in resource allocation and organizational restructuring. Long-term adaptation not only helps companies deal with current instability, but also prepares them for new risks in the future.

The next element in the integrated model is strategic collaboration within the supply chain network, whether with suppliers, distributors, or logistics partners. This collaboration includes sharing risk information, coordinating production, and developing joint planning. The OECD (2023) emphasizes that strong collaboration between companies can increase supply chain resilience through increased trust, information transparency, and more effective coordination. Companies that build long-term partnerships with suppliers have a greater ability to cope with disruptions, as suppliers tend to prioritize demand from partners with whom they have good relationships. In addition, collaboration can be carried out through shared digital platforms, which enable secure and efficient data exchange.

Integrated risk management models also include long-term structural strategies, such as geographic diversification, regionalization of production (nearshoring), or vertical integration. In the past decade, the trend toward regionalization of supply chains has strengthened as companies seek to reduce the risks of dependence on regions with potential conflicts or unstable trade policies. UNCTAD (2023) notes a significant increase in investment in Southeast Asian countries as

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alternative production centers to reduce dependence on China. In Indonesia, increasing domestic industrial capacity is also part of the national strategy to strengthen the resilience of local supply chains. Companies that implement production regionalization can reduce international logistics risks and shorten delivery times, although this strategy requires high initial investment costs.

In developing countries such as Indonesia, integrated risk management models face their own challenges. Limited technological capacity, suboptimal logistics infrastructure, and varying levels of corporate digitization make the implementation of front-line mitigation strategies uneven. BPS (2023) shows that small and medium-sized industries (SMIs) are the most vulnerable sector as most do not yet have formal risk management systems in place. In addition, SMEs usually depend on one or two main suppliers, making their supply structures more vulnerable to external disruptions. Therefore, Indonesian companies need to develop risk management models tailored to their capacities, for example through risk management training, collaboration with industry associations, or the use of low-cost digital technologies such as applications.

CONCLUSIONS

This study confirms that the instability of the global supply chain has increased companies' exposure to operational risks stemming from supplier fragility, geopolitical volatility, climate change, macroeconomic uncertainty, and technological system vulnerabilities. Through a Systematic Literature Review (SLR) approach, it was found that these risks do not exist in isolation, but rather interact and reinforce each other, requiring companies to have more adaptive and responsive risk management systems. The findings show that the integration of digital technologies such as IoT, real-time monitoring, and big data analytics, strengthens early detection and rapid response capabilities, while structural strategies such as supplier diversification and production regionalization increase long-term resilience. Companies in developing countries such as Indonesia face additional challenges in the form of dependence on imported raw materials and limited digital capacity, requiring more contextual and gradual mitigation strategies.

This research also proves that an integrated risk management model that includes holistic risk mapping, digital-based early detection, rapid response capacity, long-term adaptation, and strategic collaboration is the most effective approach to dealing with global supply chain instability. Supply chain resilience cannot be achieved through technical interventions alone, but requires structural transformation and strong risk governance at the organizational level. Companies need to develop a culture of learning, improve the quality of collaboration, and strengthen technological capacity to effectively anticipate, respond to, and recover from disruptions. The government also has an important role to play in providing regulations, digital infrastructure, and policy support that can strengthen national industrial resilience.

As a recommendation, companies are advised to expand supplier diversification, invest in digital monitoring technology, conduct routine stress testing, and build strategic collaborations within the supply chain network. The government and industry associations need to provide risk management training, strengthen the logistics ecosystem, and encourage industrial digitalization so that Indonesian companies can face global supply chain instability more resiliently. With this integrated approach, companies can improve operational resilience while strengthening their competitiveness in an increasingly uncertain global economy.

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