**TRADITIONAL AND MODERN RISK STRATEGIES IN SCM: A COMPARATIVE STUDY**

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**ABSTRACT**

Traditional and Modern supply chain risk management (SCRM) practices differ in industries and economies. This paper is an outcome of the dissertation work of comparing SCRM practices in multinational corporations from various regions worldwide. It emphasizes the transformation of SCRM through assessment and collaboration mechanisms aiming at greater operational and financial efficiencies while protecting industries and economies from disruptions by shifting from reactive to anticipatory modes. Both qualitative and quantitative approaches are employed in this study to utilize secondary data gathered from systematic reviews and primary data through the interactions with industry experts across various supply chains. The current research explores various risk mitigation tools and strategies adopted to enhance the supply chain resilience. Supply chains differ by complexity in the specific contexts of industries and economies. The identified risks and their solutions contribute towards the sustainable development goals. The analysis, findings, relevance, validity, and reliability are done with credible sources of data and proper guidance from academic and professional mentors to identify the correlation between SCRM tools and Sustainable Growth.

**Keywords:** SCRM, Traditional and Modern Risk Management, Digital Tools and Techniques, Strategies.

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1. **INTRODUCTION**

Supply Chain Management (SCM) focuses on efficient transactions from the points of origin to those of consumption by utilizing the relevant information and resources. It involves collecting raw materials, manufacturing goods; and distributing products over the supply chain. Customer satisfaction being the priority to supply chains of all companies, it is crucial to organize, execute, and oversee operations effectively. A well-planned, managed and monitored supply chain meets the customer’s needs while achieving business goals, regardless of crises, uncertainties, and risks. Crises are caused by numerous unpredictable and uncontrollable situations, resulting further into several risks with varying degrees of severity and complexity. The current research analyses the strategies to manage global supply chain risks.

Common supply chain risks include:

* Financial Risks – Shortfalls or mismanagement of capital, currency, budget and escalated cost calls for SCRM.

Solution – Investment in software that provides alerts for potential spikes in operational costs.

* Legal & Compliance Risks – Multinational organizations must adhere to country-specific legal and regulatory norms for smooth workflow to manage demography, labor, environment, society, and governance (ESG) factors.

Solution – Compliance management helps prevent production disruptions and penalty impositions.

* Environmental Risks – Environmental sustainability attracts customers and long-term economic viability.

Solution – Supply chains should comply with environmental standards and manage their carbon footprints.

* Geopolitical Risks - Geopolitical unrest compels enterprises to paradigm shift in governance and leadership.

Solution – Remaining abreast of geopolitical developments in the locations of supply chain operations.

* Cyber Risks – Modern data-driven supply chains are susceptible to cyber threats like hacking and tracking.

Solution – Securing information through cyber solution software is essential for all supply chains.

* Logistics Risks – Logistics operations directly impact the end customers for delay, damage, shortage etc.

Solution – Manage transaction visibility to uplift the delivery status as a services effectiveness.

* Workforce Risks – Logistics and supply chain operations hinges on a skilled and productive workforce.

Solution – The workforce is a key stakeholder and need to be skilled and supported to enhance productivity.

Effectively managing supply chain risks requires dynamic planning and investment in the mechanisms, schemes, and software that yield long-term benefits by averting the bottlenecks and loss of revenues.

* 1. **Supply Chain Risk Management (SCRM**)

Supply Chain Risk Management (SCRM) involves identifying, analyzing, and handling risks related to the global information and communications technology networks. It focuses on recognizing, assessing, and reducing threats that affect the reliability, security, and compliance of products and services of a supply chain. A strong SCRM approach includes developing a risk management framework and applying strategies to minimize risks like economic instability, natural disasters, and technological changes to ensure smooth and profitable business.

### Traditional Strategies for Risk Management

Traditional risk management strategies focus on identifying, assessing, and mitigating risks to protect the assets, people, and operations of an organization relying on certain well-established methods to predict and measure risks –

* Risk Avoidance – Eliminating activities and processes that carry risk in performing.

*Example -* XYZ Co. decides not to launch a new product in a highly volatile market to avoid potential losses.

* Risk Reduction: - Implementing measures/techniques to minimize the chance or impact of a risk.

*Example* - Installing fire disconnection systems to reduce the damage caused by fire.

* Risk Transfer – Transferring the financial result of a risk to a third party.

*Example* - Buying insurance or outsourcing tasks to reduce liability.

* Risk Retention: - Accepting the risk and its results when the cost of reduction is too high, or the risk is minor.

*Example* - A company may self-insure for minor property damages rather than purchasing an insurance policy.

Traditional risk management is often incapable of managing the complexity of a modern supply chain. The COVID-19 pandemic highlighted weaknesses in global supply chains, pushing companies to rethink their risk management strategies to become more resilient using technologies and data-driven approaches. When traditional risk management relies on reactive steps like keeping extra inventory or multiple suppliers, modern methods embrace technologies.

### Modern Strategies for Risk Management

The following modern risk management strategies are commonly applied in supply chains:

* Enterprise Risk Management (ERM) – Managing all types of risks through one system.

Example: A company assesses financial, operational, and cyber risks together to make better decisions.

* Data-Driven Risk Analysis: **-** Using data, AI, analytics, etc. to predict and prevent risks.

Example: Different Banks use AI to detect surprise transactions and prevent fraud.

* Cyber Risk Management: **-**Protecting businesses from online threats like hacking and data breaches.

Example: A company sets up multi-factor authentication to prevent unofficial access.

* Scenario Planning & Stress Testing: **-** Testing different "what-if" situations to prepare for surprise risks.

Example: A bank runs simulations to see if it can survive a financial crisis.

### Strategy in Isolation or Combination

The following strategies are applied in isolation or individual cases:

* Source Multiple Suppliers: This avoids disruptions. if one supplier fails for some reason ensured by another.
* Establish Near-Shore Sources: Selecting suppliers by proximity to avoid delays, and the cost thereby.
* Maintain Inventory Buffers: Having extra stock to meet unpredictable demand or supply chain delays.
* Improve Vendor Visibility: Keeping a close eye on supplier’s performance and financial health to catch problems beforehand, thus preventing disruptions by using the tracking tools and assessments.
* Model Worst-Case Scenarios: Preparing for the worst-case scenario, like a natural disaster or cyber-attack.

The following strategies are applied in combination or as a collective framework:

* + Combined sourcing from multiple suppliers and near-shore sources reduces geopolitical and delivery risks.
	+ Maintaining inventory buffers and improving vendor visibility avoids supply disruptions and demand spikes.
	+ Remain proactive to problems, especially when working with a few critical suppliers.

### Comparison Between Traditional and Modern Strategies

The following section compares the scenarios of both traditional and modern practices in some internal SCRM cases.

*Case 1:*

An established automobile company, X, launching electric cars in a new country, in a dynamic market, under unclear government policies, lack of charging infrastructure, and economic instability appear as supply chain risks.

* Traditional Strategy: The managers at X thought of not entering the new market and focusing on the existing stable market. This protects X from potential risks and losses but limits the growth opportunities.
* Modern Strategy: The managers at X thought of using ERM to analyze financial, operational, and cyber risks together and going ahead by – risk mapping; partnering with local charge-stations; and scenario building for policies.

Finally, by integrating all risk factors under ERM, X decided to expand its market presence than avoiding it.

*Case 2:*

A large online retailer, Y, maintains some customer payment data. With the rising cases of cyber-attack, Y is thinking of taking some steps to ensure security.

* Traditional Strategy: The managers of Y thought of purchasing cyber insurance, to cover the financial losses assured. The insurance reduces financial liabilities, but not the loss of data and market image.
* Modern Strategy: The managers at Y thought of relying on a cyber security software integrated to their ERP by adopting multi-factor authentication (MFA), AI-based fraud detection, and training the employees to avoid errors.

Finally, the prevention-first approach was preferred by Y to avoid data violation and reduce the transfer risk.

### Best Practices for Managing Supply Chain Risk

The best way to manage the supply chain risks and challenges is to have a SCRM framework comprising of

* Source Multiple Suppliers - Both the small and large businesses enterprises benefit from it through new employee onboarding; system implementation; no single supplier failure; diversifying the suppliers etc.
* Establish near-shore Sources - Companies found solutions to select suppliers and distributors located nearby their operations, gaining advantage of quick access and climatic problems due to short distance. Regional suppliers deliver faster by lowering the risk even at an expensive offer.
* Just-in-Time – JIT reduces inventory and warehousing costs with a baseline from previous years that helps the stakeholders with the historical data for making predictions and estimations for future inventory requirements.
* Improved Vendor Visibility - [It ensures the preparedness of the 3rd Party](https://www.auditboard.com/blog/murky-visibility-across-the-supply-chain-how-organizations-are-overcoming-tprm-roadblocks/) [vendors](https://www.auditboard.com/blog/murky-visibility-across-the-supply-chain-how-organizations-are-overcoming-tprm-roadblocks/), in terms of financial standings, and then the level of dependencies. Reviewing the vendors’ credibility, agency reports, technology competency for product shipment etc. before signing any contracts.
* Worst-Case Scenarios – Using forecasting models for worst case scenarios with backup plans. Performing tabletop exercises (TTX) for the most likely scenarios to respond in real-time basis to run the organizational activities.

### Overall, it can be summarized that the supply chains of any business can operate efficiently and meet customer demands by optimizing the resources, reducing the costs, and improving the quality. This is possible only when the supply chains operate risk-free. And to manage these risks, organizations must adopt modern strategies, including data-driven analysis, scenario planning, and proactive risk management. By combining traditional and modern approaches, businesses can build more resilient supply chains subject to contexts. A well- planned and flexible supply chain not only ensures smooth operations but also helps companies stay competitive in an ever-changing global market.

## LITERATURE REVIEW

### A wide literature review is conducted over the past five years data, credibly taken from the research articles of peer-reviewed journals for the analysis in the current research. The entire areas of review is divided int sub-areas like – key concepts and definitions; proactive risk mitigation strategies; global supply chains of business; risk management strategies in global supply chains; supply chain resilience; ERM and contingency planning around the world; advantages of ERM; and regional variation in risk management strategies. The following section is dedicated to those.

**Key Concepts and Definitions**

The term *risk* in business refers to the degree of change that may occur with a potential quantifiable negative influence and *uncertainty* is a situation where a decision-maker does not possess any information to quantify any measurable outcome [1]. Gurtu and Johny [2] define risk management as the process of identifying, analyzing, and mitigating the risks that impact the capital or earnings of a business. Haimes [3] suggests an effective management of risks with significant investment of financial and manpower resources, as equally attended the other functions.

### Proactive Risk Mitigation Strategies

Risk mitigation strategies are broadly classified into two categories - proactive and reactive. Proactive ones include supplier development and management; supply chain contracts; product and process management. Whereas reactive ones include contingency planning; disaster management; and demand management [4]. Reactive strategies are mitigation oriented, thus, difficult to control. However, proactively designed mitigation plans use collaboration [5] [6]; flexibility [7]; resilience [8]; responsiveness [9]; acquiring multiple supplier [10]; and agility [11].

### Global Supply Chains

The dynamics of global supply chains influence the business and economies with changing trends of technological advances. Ivanov et al. [12] recommended a protective belt to withstand the risks of disasters like natural calamities, trade wars, and pandemics to assure resilience and sustainability. Baryannis et al. [13] mentioned that companies with transparent and sustainable practices of supply chains recover faster from disruptions. Soleymani and Oveysi Nejad [14] indicated that in the urge for cost-cutting and efficiency, global supply chains become more vulnerable to disruptions. JIT inventory flares up the impact from any disruption, expected or unexpected, culminating into huge losses. Miranda Ackerman et al. [15] argued on the focus of efficiency, which leads many businesses to miss the importance of redundancy and flexibility in their supply chains, putting them into the risk of foregoing long-term efficiency.

Technological advances present opportunities for better global supply chain risk management. According to Queiroz et al. [16], new technologies can change the supply chain operations by using the Internet of Things (IoT), Artificial Intelligence (AI), and Blockchain opening new paths of efficiency, transparency, and security. Qazi et al. [17] mentioned that real-time tracking of goods, inventories, and their transactions collectively stopping the risks to creep into the global supply chains. Mital et al. [18] stated the importance of strategic requirement in the diversification of supplies during disruptions like COVID-19 pandemic. The reliance on a single or a few suppliers subject to greater risks. Where diversification generates complexity, technology brings a challenging solution. Júnior et al. [19] and Cui et al. [20] recommended the adoption of digital technologies to enhance transparency and real-time tracking and monitoring the progress of supply chains easily managing the risks in a proactive manner. For example, blockchain enables traceability and security beyond anything noticed or experienced, thus, lowering the risk of fraud and compliances.

Kozlowski et al. [21] criticized the lack of sustainability practices in global supply chains due to their major focus on the economic side of efficiency overshadowing the social and environmental considerations. Based on the factors different authors classified the supply chain risks as follows.

* Sourcing Risks arise due to supply chain disruptions, inability to control the flexibility, material quality, purchasing cost, and supplier relationship. [22][23][24][25]
* Manufacturing Risks arise due to operations breakdown, design variations, capacity constraints, integrated outsourcing, quality and cost. [26][22][27][25][28]
* Delivery Risks arise due to demand variation, forecast error, new product introduction, variety, surplus inventory, logistics reliability, service quality, logistics cost. [23][29][30]

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### Supply Chain Resilience

Caniato [31] and Fiksel et al. [32] define supply chain resilience as the capacity to survive, adapt and grow in the turbulent times. Hohenstein et al. [33] defined it as the capability to cope with, adapt to or withstand the unexpected events (i.e. risks) and suggested four stages - readiness, response, recovery and growth. Definitions also came up by relating to consequences by coping [34] and by minimizing [35]. Different researchers defined in different ways e.g. adaptive capacity [36][37][38], impact free [39] and counteractive [40]. However, the robustness of the supply chain enables the connectivity and controls by structure and function [41][42] providing resilience as a competitive advantage. Supply chains use flexibility and agility to manage uncertainty [43] as the competitive advantages [44]. A global supply chain tackles potential risks like defectives and inventory surplus to prove their resilience [45], which mitigates the actual impact of risk [46] being seen as an organizational competence for risk environment [47][48].

### ERM and Contingency Planning Around the World

Risk management and contingency planning are two widely addressed topics in business management. Norman and Jansson [49] analyzed Ericsson's risk management strategies to mitigate the supply chain risks after a serious sub-supplier accident. The company had to address the risks arising from the failure of a sub-supplier in one of the major contracts of the company. As a result, it was found that the underestimation of the risks arising from the supply chains could result in devastating impacts, as Ericsson failed to monitor and control the risks.

Many authors focused on the social, health, and environmental risk management in both developed and developing countries [50][51]. The common social crises, such as the spread of infectious diseases, environmental disasters and others, were found to influence the well-being of the enterprises. On the contrary, Wu and Olson [52] examined the common risks of the small business by focusing on the European companies. According to authors, the main risks for small businesses in the region included the liquidity risk, high levels of competition and inadequate capital management practices. On the other hand, Ekwere [53] studied enterprise risk management and contingency planning in the case of the small and medium enterprises (SMEs) in OECD countries. According to the author, SMEs are exposed to greater risks due to the firm size and constrained access to the capital for the further growth of the business. Moreover, the research results indicated that SMEs were more vulnerable to the external risks than large multinational enterprises, which can be explained by the existence of the well-developed enterprise risk management and contingency planning tactics among multinational enterprises.

Moreover, Zhao and et al. [54] has conducted research work examining the success factors of enterprise risk management among the Chinese companies. The research evidence suggests that the Chinese construction companies developed highly effective risk management practices, which was partially due to the industry requirements as well as regulations that were strict in case of Chinese construction and the real-estate market.

### Enterprise Risk Management (ERM)

Effective implementation of ERM can positively impact a firm's performance [55]. Research from Indonesian companies shows a positive correlation between ERM and firm performance, but not any positive impact on the corporate governance. Further, Acharya [56] stated that the implementation of simple risk management techniques like balanced scorecards positively contributed on the risk exposure of insurance companies. Also, Naik and Prasad [57] highlighted the benefits of ERM like cost effectiveness, stable earning of firms, increased profit levels, enhanced decision-making, better risk communication and overall value enhancement of the firms. The researchers showed the necessity of ERM in unstable economies.

### Regional Variations in Risk Management Strategies

A comparison of risk management strategies across different regions shows significant differences.

* North American companies emphasize compliance and technology-driven solutions such as AI, blockchain, and automation to enhance supply chain transparency and efficiency.
* European firms integrate sustainability and corporate social responsibility in their risk frameworks driven by strict regulatory mandates [58].
* Asian supply chains adopt lean and Just-In-Time (JIT) practices to mitigate risks associated with demand fluctuations and market instability.
* Emerging markets in Latin America and Africa face challenges related to infrastructure deficiencies and political instability, necessitating supplier diversification and localized sourcing [59].

The following table of research anecdotes lays a fundamental understanding of some studies and areas of SCRM:

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Authors** | **Articles** | **Anecdotes** |
| **2018** | Christopher & Peck [60] | Building resilient supply chains through modern risk management | Resilience can be achieved through collaboration, flexibility, and visibility by using ERM. |
| **2019** | Scholten, Schilder [61] | Collaboration in risk management for resilience in supply chains | Showed that collaboration between stakeholders increases resilience to disruptions through shared resources and knowledge. |
| **2020** | Ivanov & Dolgui [62] | Ripple effect in supply chains | Discussed the cascading impacts of supply chain disruptions and stressed the importance of proactive risk management measures. |
| **2021** | Soni & Kodali [63] | Framework for Hybrid risk management strategies | Proposed a combination of traditional and modern methods to address evolving risks while maintaining cost-efficiency. |
| **2022** | Shi, Fang [64]Sharma & Joshi [65] | Adapting risk management strategies in uncertain marketsDigital supply chain management in emerging economies | Focused on adapting risk management approaches to market volatility by leveraging advanced data-driven tools.Highlighted the challenges and benefits of adopting digital solutions in emerging economies' supply chains. |
| **2023** | Zhang, Li [66]Gupta, Patel [67] | Artificial Intelligence in Risk Management StrategiesSustainability and risk management in modern supply chains | Analyzed the integration of AI to automate decision-making and optimize responses to supply chain disruptions.Addressed the need for balancing sustainability goals with risk management strategies, usingintegrated frameworks. |

**Table 1: Anecdotes of literatures in the area of supply chain risk management**

The discussion in this section narrates important studies on the topic explaining different views and findings. It further talks about how researchers have studied the subject, the methods they adopted, and their interpretations. It also points out gaps where further research is required to explore the same.

1. **METHODOLOGY**

The current research reviews traditional and modern risk management strategies applied in the supply chains in various countries by using a combination of qualitative and quantitative methods. It is intended to understand the business risks in supply chains. The temporal and spatial constraints led the researcher to work with secondary data. A few case studies are examined to check the implication of risk management strategies and their impacts. The research method is justified for possible advantages and disadvantages, samples, and all ethical concerns. It illustrates in-depth reviews and interpretations on risk management practices [68] as useful as contextual strategies for different industries. The approach includes the plan and methodologies for collecting, analyzing and interpreting the data by testing the underpinning theories and structures on risk management of the global supply chains. It begins with formulating the assumptions in a deductive manner providing a structured environment to test the relevant concepts as recommended by Flick [69], ensuring the effectiveness of risk management strategies. The research technique obtains the data on perceptions in the global supply chain risk management strategies. The qualitative data collected from the secondary sources include the experiences, practices, and points of view with reference to the research recommendations. This method understands the contextual and shadow elements of risk management to quantify the elements practiced in different industries. However, the qualitative focus does the screening of risk management strategies. The data is relevant to the current trend and practices of risk management in global supply chains, duly ensured by their competitive and innovative outcomes. It appropriately compares different risk management strategies to fulfil the objectives, ethically following the reliability aspects and eliminating all kinds of bias and ambiguity.

### Research Objectives

* Establishing the relevance of secondary data with the outcomes of risks.
* Reviewing the data with a special focus on the theories and practices of the global supply chains.
* Identifying the best practices through the interactions with professional practitioners.

## DATA ANALYSIS

The researcher selected appropriate secondary source for articles, case studies, and business reports logically connecting to the queries on the research questions and assumptions to meet the quality and depth of information. The content analysis adequately explores the information from these sources to provide a concise understanding of the practices and outcomes of executing various risk management strategies.

It seems from analysis that global supply chains suffer from various levels of risks in different industries of different countries. The rising risks are reasoned by different attributes. The global supply chains operating in multiple locations with multiple business entities started adopting decisions and approaches to remain resilient in the dynamic market. The *Global Risks Report 2025* [71] released by the World Economic Forum highlights the big threats to be faced worldwide in the near future, based on a survey. This report thus became the master reference to pick up the direction for data analysis in the top five risk areas in the current research.

**Figure 1: Top Five Risks for the Year 2025**

[Source: (Adapted from) Global Risks Reports 2025, World Economic Forum]

*War & Conflicts:* Conflicts between countries become the top global risk including reasons like territorial disputes, resource conflicts, aggressive foreign policies (e.g. sanctions, duties, tariffs, taxes), and geopolitical risks.

*Weather or Climate:* The risk of weather conditions, and natural disasters (e.g. heatwaves, floods, storms, cyclones, greenhouse effect) arising often in different parts of the globe causing greater damages to supply chains.

*Economic Conflicts:* This refers to disagreements or clashes over economic matters by groups, individuals, companies, or nations (e.g. trade wars, sanctions, and financial restrictions) leading to disruption in global supply chains, simultaneously hindering the overall growth and smooth business operations.

*Misinformation:* The rapid spread of misinformation by digital social media, and political propaganda, leads to differences among the people creating lines of divisions and badly affecting the global supply chain operations.

*Social Conflicts:* Modern societies are increasingly divided by politics, economics, and social issues, leading to protests, instability, and growing varieties of conflicts fueled by inequality, insecurity, and extremism.

Other risks include a large number of business and trade-related risks put together that arise in the supply chains.

Looking ahead from 2027 to 2030, misinformation will become the greatest risk, followed by extreme weather events, wars, societal polarization, and AI-technology-cum-cyberthreats to the world with no exception to supply chains. Towards 2035, environmental risks such as extreme weather are likely to take the top spot, followed by biodiversity loss, ecosystem collapse, critical changes in the Earth's systems (including rising average global temperatures), and shortages of natural resources, while misinformation to follow further.

|  |  |  |  |
| --- | --- | --- | --- |
| **Timeline (years):****Rank of Risks:** | **2025** | **2030** | **2035** |
| 1 | War and Conflicts | Misinformation | Weather or Climate |
| 2 | Weather or Climate | Weather or Climate | Biodiversity  |
| 3 | Economic Conflicts | War and Conflicts | Ecosystem Changes |
| 4 | Misinformation | Social Conflicts | Shortage of Natural Resources |
| 5 | Social Conflicts | Tech./Cyber Threats  | Misinformation |

**Table 2: Forecasting the Top Global Risks in Five Years Intervals**

The above analysis shows that worldwide people will recognize the losses and damages to lives and assets due to wars and armed conflicts to subside by 2030 and further by 2035. Weather and climatic changes may not be controlled by the worldwide community as it requires a strong collectively agreed action, which is not that easy. Economic conflicts will be controlled gradually by adopting universally optimized approaches. Misinformation is expected to behave as a fluctuated control like upgrading and offsetting kind of approaches out of human behavior. Social conflicts are expected to rise due to the changing trends and exchange of global culture. All these risks will have a continuous impact on the supply chains operating on a global scale.

### Analytical Findings

Technological advances have transformed SCRM enabling predictive analytics and real-time decision-making. AI-driven models enhance risk assessments by identifying vulnerabilities before disruptions [72]. Blockchain technology improves supply chain transparency, reducing fraudulent risks [54]. Companies started adopting blockchain-based security protocols to mitigate cyber threats [73].

Supply chains worldwide face many risks that can disrupt operations, increase costs, and impact business continuity. A recent survey highlights the greatest risks that supply chains are exposed to, offering valuable insights into the challenges companies must address through effective risk management strategies.



**Figure 2: Survey participants' views on the greatest risks to which their supply chains are exposed**

Source: According to a PwC survey report (as referenced in Merlin Sourcing Blog [https://merlinsourcing.com/de/blog/supply-chain-risk-management-everything-you-need-to-know/]) [74]

|  |  |  |  |
| --- | --- | --- | --- |
| **Types of risks** | **Classification** | **Cause** | **Impact** |
| Cyber Attack | Low risk | Hacking, Phishing, malware | They pose threats to digitalized and automated supply chains. |
| Telecommunication Outrages | Low risk | Hacking, Phishing, malware | They pose threats to digitalized and automated supply chains. |
| Others | Low risk | Unknown factors or uncertainties | Disruption in SCM |
| Counterfeiting | Low risk | Any fake or low-quality products entering the supply chain  | Leading to brand reputation damage, financial losses, and bad effects |
| Unplanned IT disruptions | Low risk | System failures, cyber incidents, and software downtime  | Can slow down supply chain operations |
| Change in technology | Emerging risk | Businesses may face resistance to change from their employees  | Investing resources in their training and development would ultimately lead to an increase in the cost of operations |
| Supplier/partner bankruptcy | Emerging risk | Financially failure of important supplier | Disruption in production lines  |
| Geopolitical instability | Emerging risk | Trade wars, conflicts, and sanctions create uncertainty in international supply chains | Effects on imports, exports, and supplier relationships |
| Rising labour costs | Medium risk | Inflation, labour shortages, and increasing production  | Can create a financial burden on supply chain operations and are very difficult to manage. |
| Raw material scarcity | Medium risk | Shortages in essential raw materials like semiconductors, metals, or agricultural products  | Can stop manufacturing and supply chain flows |
| Environmental catastrophes | Medium risk | Natural disasters, climate change, and extreme weather conditions  | Impact on production, transportation, and supplier availability |
| Energy/fuel price volatility | Top risk | High demand and scarcity | Effects transportation costs, logistics, and overall operational costs significantly |
| Market changes | Top risk | Sudden shifts in consumer demand, economic conditions, and industry trends  | Supply chain disruption and either shortage or overstocking |
| Currency fluctuation | Top risk | Involvement of multiple currencies in global trade | Import/export costs, supplier pricing |
| Raw material fluctuations | Top risk | Scarcity, Geopolitical issues | Increases in cost of production |

**Table 3: Types of Risks, classification, cause, and Their Impact on SCM [75]**

Figure 2 and Table 2 together provide insights into the most pressing threats affecting global supply chains, ranked by the percentage of respondents who identified them as critical concerns. The total percentage in the graph exceeds 100% because the survey likely allowed multiple responses per participant rather than limiting them to just one risk. These figures show how frequently each risk was mentioned, not a sum-total ranking. The higher the percentage, the more businesses perceive that factor as a threat. It’s a common way to present survey data where multiple answers are allowed.

### Comparative Analysis of Risk Management Strategies

There are two categories of risk situations: the likelihood of occurrence, which means the probability that an event or hazard will occur, and the second is the severity of consequences, which means the extent of damage or harm that could result if the event occurs.

Risk assessment means analyzing the above two components to determine the risk level associated with a particular hazard.

Understanding it by a simple example, say Mr. X has to cross a road and he is trying to find out what the risk associated with this is by different scenarios

*Scenario 1*: let's assume the road is not busy and there are only bicycles allowed on this road and there is only 1 bicycle every 5 minutes on that road now Mr. X’s hazard is a bicycle and bicycles don’t go on that road often, then the likelihood of the bicycle crashing Mr. X is low even if the bicycle does crash, the consequence of that would be relatively low. So, in this case, the consequences and the likelihood are both low therefore the overall risk is low.

*Scenario 2:* Following the previous scene, if bicycles travel more frequently, the likelihood of a crash would increase, but the consequences of these crashes would still be low.

*Scenario 3:* In Scenario 1, if we replace the bicycle with a truck that passes every 5 minutes, the likelihood of a crash would remain low; however, the consequences would be significantly more severe.

*Scenario 4:* If this is a busy truck route with frequent truck traffic, then both the likelihood of a crash and the consequences would be high, meaning the overall risk would also be high, leading Mr. X to avoid crossing that road.

A straightforward way to visualize this and assess the overall level of risk is by using a Risk Matrix. In the risk matrix, information about consequences and likelihood can be utilized to determine the overall risk level.



**Figure 3: Strategic Risk Severity Matrix in Bar Graph Format**

**Source: LaConte Consulting**

**(htps://laconteconsulting.com/2018/12/02/calculate-impact-and-probability/amp/) [76]**

Here we predict and rate the likelihood of occurrence of an event again from 1 to 5, and the severity of consequences in a similar way as well from 1 to 5, then according to Figure 3, Scoring is done by multiplying these two numbers. This number corresponds to the level scoring result: Controlled marked as blue colour, Serious marked as green colour, Disruptive marked as yellow color, Severe marked as orange color, and Critical marked as red colour, as outlined in the diagram.

Controlled (a score of 1 and 2): in which only limited monitoring is required; Serious (a score of 3, 4, 5, and 6): where active monitoring is required; Disruptive (a score of 8 and 9): in which investigation needed; Severe (a score of 10, 12, 15, and 16): Rapid action required; Critical (a score of 20 and 25): Immediate or crucial priority.

*An Interesting Case:*

This Strategic Risk Severity Matrix can be applied in daily life or business. Suppose an individual, Mr. N, owns a health service business and notices a sudden drop in customers. Upon reviewing the numbers, it becomes clear that several customers stopped using his services for various reasons, such as frequent and loud complaints, needing lots of reassurance, expecting frequent phone calls and updates, frequently changing their minds, demanding refunds for services rendered, paying late or refusing to pay, or being rude to the staff, etc.

It is important to determine whether this is a significant problem or one that can be monitored. Instead of placing blame or trying to solve the issue immediately, a more effective approach would be to address the problem logically.

Analysis shows that the overall customer rate has dropped by 10% in the past month, from 100 active customers to 90. Out of the 10 customers who left, 4 were new, and 6 were repeat customers. Three of the departing customers were significantly profitable, with a high cost-to-profit ratio (they generated more sales than the business costs).

The loss of these three customers represents a profit loss of 4%. Four out of the 10 departing customers were challenging to deal with.

What measures can be taken in this situation?

Mr. N can assign a numeric equivalent to the amount of impact that reflects the degree of negative change resulting from this problem.

Considering that 4 out of 10 customers were difficult and potentially not ideal, it is rational to recognize that both new and repeat customers are important, but repeat customers tend to have a greater positive impact in the long-term perspective.

If new customers decline, this shift could negatively affect other customers, staff, or projected sales targets.

Among the 10 departing customers, 4 were highly profitable. The loss of these customers could impact future sales, particularly since these were repeat customers and loyal buyers.

A financial analysis at this stage to evaluate profit margins could reveal if this problem may continue affecting sales.

If Mr. N is confident that this change will not lead to significant long-term issues like damaging goodwill or spreading negativity about the business to other customers, he may rate it as 3.

While it is unlikely that the departing customers will return, Mr. N should consider the possibility of this happening again.

Since he has not fully established the reasons behind the 10% customer loss, it is quite probable that more customers might leave as well.

Without further data, the assumption must be that this risk is fairly high. Thus, Mr. N should rate it as 5.

The impact score of 3 and the probability score of 5 would be 3 \* 5 = 15.

Based on the score, this problem (10% of customers departing) affects the health of the business. Therefore, one can adjust policies, enhance communication with existing customers so they become fully aware of the circumstances, educate staff, and change the services and products currently being provided. The same thing could continue to happen unless a root cause analysis and investigation of the reasons for the customers who have already departed.

### Discussion

Everything works well when all plans get organized well. If there are mistakes or missing pieces, things slow down and become less effective. Better plans can fix the issues to make a big difference. Flexibility in the plans also helps manage the situations. An adaptable system remains free from struggle, moving forward with no major problems. Using the time, money, and resources wisely is a key. Even small wastes add up retard the progress. Paying attention to details and making smarter choices prevents problems before happening. Good planning results with few mistakes and delays. Teamwork and communication further results with shared information in faster and better ways.

## SCOPE AND LIMITATIONS

## Every research starts with the scope and ends with its limitations. In this context, the gravity of supply chain risk is always high. The inherited complexity brings cascading effect across the entire chain when a single weak link gives way. Disruptions at different stages have different impacts finally affecting the damage to financial health and reputation of an organization. For example, the 2021 Suez Canal blockage disrupted 12% of global trade. It costs the world’s businesses $400 million per hour. Similarly, the COVID-19 pandemic was noticed by all how it affected the global supply chains, a record of 94% of Fortune 1000 companies experienced interruptions. Disruptions from unexpected geopolitical tensions, and extreme weather events, have become the common unpredictable of the era. A single minute of downtime or delay in a global supply chain costs millions of dollars due to distributed ownership of the socio-commercial liabilities. If the input does not arrive on time, then the factory gets shut down; and if the finished products are not shipped out, potential sales are lost; also the warehouses and distributors incur huge losses.

Conventional methods like periodic reviews or audits paired with manual interventions no longer holds good for the associated risks of the business world. Rather a chaos theory works here for any small change, anywhere in the world. For example, a luxury garment brand based in France sources its fabric from India and manufactures in Singapore. Suppose monsoons hit India, and the fabric factory gets flooded, then the Singapore factory remains idle for a week or two. Suppose after the fabric is ready, the Singapore factory workers go on strike, then the compounded risks cause significant delays, costing the brand money, time, and reputation. Traditional risk management methods react to one issue and cannot predict or address compounded risks in real time. Where the modern risk management helps businesses stay ahead of problems. AI can predict heavy monsoons in India so that the company stocks up on fabric or finds an alternative supplier. The strike in Singapore can plan to outsource orders to another factory. Similarly, real-time tracking helps by rerouting shipments, and quick communications with customers. The use of smart tools can avoid major delays, save money, and smoothen operations. But, AI and other technological adoptions raise resistance by employees and investors. This may be addressed by motivation of people and justifying the faster decision in multi-layered approvals, where time is money.

Overall, the traditional method is cheaper, but slower, where the modern tools enhance both speed and accuracy. The future trends in supply chain risk management indicate a shift toward sustainability and decentralized supply chains. The COVID-19 pandemic highlighted vulnerabilities in centralized supply networks, prompting firms to explore regionalized production and nearshoring strategies. Environmental, Social, and Governance (ESG) considerations are increasingly shaping risk management frameworks, ensuring alignment with sustainability goals.

However, there are some limitations too, such as difficulties in accessing smart corporate risk data and its variations across different industries and countries. Modern risk management tools like AI, Blockchain, Power BI, Tableau, and SAS still require human intervention for the final decisions. These tools merely suggest solutions but need people to implement by applying their intelligence and using technology as an enabler without any errors and threats.

## CONCLUSION

The supply chain risks are not limited to a single stakeholder; instead disrupt the whole chain when they arise. A financial crisis in one country affects worldwide as a disruption to many regions. This highlights the importance of a proactive and integrated risk management approach to consider both national and international factors. Businesses must build resilience by diversifying supply chains, investing in technology, and fostering strong cultures. Some countries strictly adhere to fixed rules, while others prefer flexible ones to adapt to dynamic environments. For instance, developed nations like the US, Russia, and China often have clear, well-defined policies and regulations for managing financial, operational, and strategic risks. In contrast, developing countries like India focus more on adaptive and situational approaches due to distinct economic and political conditions. Companies that combine structured plans with innovative ideas tend to manage risks better despite differing laws of lands. Organizations operating in multiple regions must navigate these variations carefully to ensure compliance and efficiency.

Traditional risk management alone no longer suffices with increasingly complex businesses of the market, economy, politics, and technologies. Learning from world class best practices and blending them carefully in the plan, policy, compliances, and modern tools can strengthen risk management practices. This is possible through business data analytics; supply chain analytics; and digital innovations to anticipate and manage potential future threats.

As businesses expand beyond national borders encounter new risks like currency ratios, trade regulations, and geopolitical instability. Effectively managing these risks requires companies to stay informed about international developments and adjust their strategies accordingly. Collaborating with local experts and regulatory bodies is useful to navigate the complex global risks calling for the role of governments and regulatory bodies. Some of the countries enforce the regulations strictly to comply with to remain risk free, while others adopt lenient policies to ease out the process of doing business. International collaboration and standardization of risk management practices foster a stable business environment. Learning from nations practicing robust risk management offers valuable insights to reassess, update and improve own strategies. The global business landscape of past few years may not be resolved by the earlier strategies. Regular risk assessments, scenario planning, and employee training can help organizations stay prepared for emerging challenges. Business leaders must establish a risk-aware culture within their organizations in which employees understand and prioritize their tasks to remain resilient. Companies that consistently evaluate their risk landscape, adopt new technologies, and learn from international best practices are better prepared to manage their risks and uncertainties. The insights derived from this study may assist business leaders, governments, and managers in refining their strategies to frame a robust risk management policy for their respective industries and economies.

### Reference

1. Johnson, J. G., & Busemeyer, J. R. (2010). Decision making under risk and uncertainty. *Wiley Interdisciplinary Reviews: Cognitive Science*, *1*(5), 736-749.
2. Gurtu, A., & Johny, J. (2021). Supply chain risk management: Literature review. *Risks*, *9*(1), 16.
3. Haimes, Y. Y. (2018). *Modeling and managing interdependent complex systems of systems*. John Wiley & Sons.
4. Ghadge, A., Dani, S., & Kalawsky, R. (2012). Supply chain risk management: present and future scope. *The international journal of logistics management*, *23*(3), 313-339.
5. Fareri, D. S., Chang, L. J., & Delgado, M. R. (2015). Computational substrates of social value in interpersonal collaboration. *Journal of Neuroscience*, *35*(21), 8170-8180.
6. Chang, S., Hu, B., & He, X. (2019). Supply chain coordination in the context of green marketing efforts and capacity expansion. *Sustainability*, *11*(20), 5734.
7. Ivanov, D., Sokolov, B., & Dolgui, A. (2014). The Ripple effect in supply chains: trade-off ‘efficiency-flexibility-resilience’in disruption management. *International Journal of Production Research*, *52*(7), 2154-2172.
8. Brandon‐Jones, E., Squire, B., Autry, C. W., & Petersen, K. J. (2014). A contingent resource‐based perspective of supply chain resilience and robustness. *Journal of Supply Chain Management*, *50*(3), 55-73.
9. Kim, M., Suresh, N. C., & Kocabasoglu-Hillmer, C. (2013). An impact of manufacturing flexibility and technological dimensions of manufacturing strategy on improving supply chain responsiveness: Business environment perspective. *International Journal of Production Research*, *51*(18), 5597-5611.
10. Wang, T. K., Zhang, Q., Chong, H. Y., & Wang, X. (2017). Integrated supplier selection framework in a resilient construction supply chain: An approach via analytic hierarchy process (AHP) and grey relational analysis (GRA). *Sustainability*, *9*(2), 289.
11. Braunscheidel, M. J., & Suresh, N. C. (2009). The organizational antecedents of a firm’s supply chain agility for risk mitigation and response. *Journal of operations Management*, *27*(2), 119-140.
12. Hosseini, S., Ivanov, D., & Dolgui, A. (2019). Acharyya, M. (2008). The impact of enterprise risk management on insurers: Examining the moderating role of reinsurance and capital market. *Risk Management and Insurance Review*, 11(2), 249-278.
13. Baryannis, G., Validi, S., Dani, S., & Antoniou, G. (2019). Supply chain risk management and artificial intelligence: state of the art and future research directions. *International journal of production research*, *57*(7), 2179-2202.
14. Soleymani, M., & Nejad, M. O. (2018). Supply Chain Risk Management using Expert Systems. *International Journal of Current Engineering and Technology*, *8*(04), 2-8.
15. Sundqvist-Andberg, H., & Åkerman, M. (2021). Sustainability governance and contested plastic food packaging–An integrative review. *Journal of Cleaner Production*, *306*, 127111.
16. Queiroz, M. M., Telles, R., & Bonilla, S. H. (2020). Blockchain and supply chain management integration: a systematic review of the literature. *Supply chain management: An international journal*, *25*(2), 241-254.
17. Qazi, S. A., & Khalid, R. U. Analyzing the digital and sustainable supply chain intersection in emerging economies: A social capital perspective. In *EurOMA Sustainable Operations and Supply Chains Forum 2023*.
18. SINGH, C., MITAL, M., GUPTA, P., & SYAL, M. Skill development: The status and challenges in India.
19. Lima-Junior, F. R., Oliveira, M. E. B. D., & Resende, C. H. L. (2023). An overview of applications of hesitant fuzzy linguistic term sets in supply chain management: the state of the art and future directions. *Mathematics*, *11*(13), 2814.
20. Chen, F., Xiao, Z., Cui, L., Lin, Q., Li, J., & Yu, S. (2020). Blockchain for Internet of things applications: A review and open issues. *Journal of Network and Computer Applications*, *172*, 102839.
21. van Deventer, O., Spethmann, N., Loeffler, M., Amoretti, M., van den Brink, R., Bruno, N., ... & Wilhelm-Mauch, F. K. (2022). Towards European standards for quantum technologies. *EPJ Quantum Technology*, *9*(1), 33.
22. Tang, O., and S. N. Musa. 2011. “Identifying Risk Issues and Research Advancements in Supply Chain Risk Management.” *International Journal of Production Economics* 133: 25–34.10.1016/j.ijpe.2010.06.013
23. Manuj, Ila & Mentzer, John. (2008). Global Supply Chain Risk Management. International Journal of Physical Distribution & Logistics Management. 38. 192-223.
24. Sreedevi, R., Saranga, H. (2017): Uncertainty and supply chain risk: The moderating role of supply chain flexibility in risk mitigation. – International Journal of Production Economics 193: 332-342.
25. Bak, O. (2018). Supply chain risk management research agenda: from a literature review to a call for future research directions. *Business Process Management Journal*, *24*(2), 567-588.
26. Tummala, V. & Schoenherr, Tobias. (2011). Assessing and managing risks using the Supply Chain Risk Management Process (SCRMP). Supply Chain Management: An International Journal. 16. 474-483.
27. Olson, D. L., & Wu, D. D. (2010). A review of enterprise risk management in supply chain. *Kybernetes*, *39*(5), 694-706.
28. Wang, Z., Ye, F., & Tan, K. H. (2014). Effects of managerial ties and trust on supply chain information sharing and supplier opportunism. *International journal of production Research*, *52*(23), 7046-7061.
29. Giannakis, M., & Papadopoulos, T. (2016). Supply chain sustainability: A risk management approach. *International journal of production economics*, *171*, 455-470.
30. Meixell, M. J., & Gargeya, V. B. (2005). Global supply chain design: A literature review and critique. *Transportation Research Part E: Logistics and Transportation Review*, *41*(6), 531-550.
31. Cagliano, R., Caniato, F., & Spina, G. (2003). E‐business strategy: how companies are shaping their supply chain through the internet. *International Journal of Operations & Production Management*, *23*(10), 1142-1162.
32. Fiksel, J. (2015). From risk to resilience. In *Resilient by design: Creating businesses that adapt and flourish in a changing world* (pp. 19-34). Washington, DC: Island Press/Center for Resource Economics.
33. Hohenstein, N. O., Feisel, E., & Hartmann, E. (2014). Human resource management issues in supply chain management research: a systematic literature review from 1998 to 2014. *International Journal of Physical Distribution & Logistics Management*, *44*(6), 434-463.
34. Jüttner, U., & Maklan, S. (2011). Supply chain resilience in the global financial crisis: an empirical study. *Supply chain management: An international journal*, *16*(4), 246-259.
35. Verbano, C., & Venturini, K. (2011). Development paths of risk management: approaches, methods and fields of application. *Journal of Risk Research*, *14*(5), 519-550.
36. Peck, H. (2005). Drivers of supply chain vulnerability: an integrated framework. *International journal of physical distribution & logistics management*, *35*(4), 210-232.
37. Bhamra, R., Dani, S., & Burnard, K. (2011). Resilience: the concept, a literature review and future directions. *International journal of production research*, *49*(18), 5375-5393.
38. Golgeci, I., & Y. Ponomarov, S. (2013). Does firm innovativeness enable effective responses to supply chain disruptions? An empirical study. *Supply Chain Management: An International Journal*, *18*(6), 604-617.
39. Klibi, W., Martel, A., & Guitouni, A. (2010). The design of robust value-creating supply chain networks: a critical review. *European journal of operational research*, *203*(2), 283-293.
40. Kumar, S., & Sosnoski, M. (2011). Decision framework for the analysis and selection of appropriate transfer pricing for a resilient global SME manufacturing operation–a business case. *International Journal of Production Research*, *49*(18), 5431-5448.
41. Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The international journal of logistics management*, *20*(1), 124-143.
42. Pettit, T. J., Croxton, K. L., & Fiksel, J. (2013). Ensuring supply chain resilience: development and implementation of an assessment tool. *Journal of business logistics*, *34*(1), 46-76.
43. Stavrulaki, E., & Davis, M. (2010). Aligning products with supply chain processes and strategy. *The International Journal of Logistics Management*, *21*(1), 127-151.
44. Augier, M., & Teece, D. J. (2007). Dynamic capabilities and multinational enterprise: Penrosean insights and omissions. *Management international review*, *47*, 175-192.
45. Gunasekaran, A., Subramanian, N., & Rahman, S. (2015). Supply chain resilience: role of complexities and strategies. *International Journal of Production Research*, *53*(22), 6809-6819.
46. Hasani, A., & Khosrojerdi, A. (2016). Robust global supply chain network design under disruption and uncertainty considering resilience strategies: A parallel memetic algorithm for a real-life case study. *Transportation research part e: logistics and transportation review*, *87*, 20-52.
47. Teller, C., Alexander, A., & Floh, A. (2016). The impact of competition and cooperation on the performance of a retail agglomeration and its stores. *Industrial marketing management*, *52*, 6-17.
48. Brusset, X., & Teller, C. (2017). Supply chain capabilities, risks, and resilience. *International journal of production economics*, *184*, 59-68.
49. Norrman, A., & Jansson, U. (2004). Ericsson’s proactive supply chain risk management approach after a serious sub-supplier accident. *International Journal of Physical Distribution and Logistics Management,* *34*(5), 434–456.
50. Rigby, D., & Bilodeau, B. (2011). Management tools and trends 2015. *Bain & Company*.
51. Coker R, Mounier-Jack S. 2006. Pandemic influenza preparedness in the Asia-Pacific region. The Lancet 368: 886–9
52. Olson, D. L., & Wu, D. D. (2010). *Enterprise risk management models* (No. 273102). Heidelberg: Springer.
53. Ekwere, N. (2016). Framework of effective risk management in small and medium enterprises (SMESs): a literature review. Bina Ekonomi, 20(1), 23-46.
54. Zhao, L., Huo, B., Sun, L., & Zhao, X. (2013). The impact of supply chain risk on supply chain integration and company performance: a global investigation. *Supply Chain Management: An International Journal*, *18*(2), 115-131.
55. Muslih, M. (2024). Firm’s Value: Governance, Risk Management, Compliance (GRC) and Profitability. *Riset Akuntansi dan Keuangan Indonesia*, *9*(2), 190-199.
56. Acharyya, M. (2008). In measuring the benefits of enterprise risk management in insurance: An integration of economic value added and balanced score card approaches. *ERM Monograph*, 1-25.
57. Naik, S., & Prasad, C. V. (2021). Benefits of enterprise risk management: A systematic review of literature. *Reference to this paper should be made as follows: Naik, S*, 28-35.
58. Sheffi, Y. (2020). 5. The Financial Crisis and the Money Supply Chain. *The Power of Resilience*.
59. Srivastava, M., & Rogers, H. (2022). Managing global supply chain risks: effects of the industry sector. *International Journal of Logistics Research and Applications*, *25*(7), 1091-1114.
60. Christopher, M. and Peck, H. (2004), “Building the resilient supply chain”, International Journal of Logistics Management, Vol. 15 No. 2, pp. 1-13.
61. Scholten, K. and Schilder, S. (2015), “The role of collaboration in supply chain resilience”, Supply Chain Management: An International Journal, Vol. 20 No. 4, pp. 471-484.
62. Ivanov, D., & Dolgui, A. (2020). A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0. *Production Planning & Control*, 32(9), 775-788. [69]
63. Soni, G., & Kodali, R. (2015). An empirical investigation of supply chain management excellence framework in Indian manufacturing industry. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, *229*(2), 343-364.
64. Liu, F., Fang, M., Xiao, S., & Shi, Y. (2025). Mitigating bullwhip effect in supply chains by engaging in digital transformation: the moderating role of customer concentration. *Annals of Operations Research*, *344*(2), 825-846.
65. Sharma, M., & Joshi, S. (2023). Digital supplier selection reinforcing supply chain quality management systems to enhance firm's performance. *The TQM Journal*, *35*(1), 102-130.
66. Jia, F., Li, K., Zhang, T., & Chen, L. (2024). Triple A supply chain management and sustainability. *Industrial management & data systems*.
67. Gupta, C. P., & Patel, A. R. (2022, August). Scope and Challenges of Blockchain in Indian Supply Chain Transformation for MSMEs. In *2022 International Conference on Emerging Techniques in Computational Intelligence (ICETCI)* (pp. 115-120). IEEE.
68. Xie, J., Zhang, W., Liang, L., Xia, Y., Yin, J., & Yang, G. (2018). The revenue and cost sharing contract of pricing and servicing policies in a dual-channel closed-loop supply chain. *Journal of Cleaner Production*, *191*, 361-383.
69. Flick, A. (2018). Intermodal transport in emerging supply chains: United States and European union perspective.
70. Kumar, R. L., & Park, S. (2019). A portfolio approach to supply chain risk management. *Decision Sciences*, *50*(2), 210-244.
71. *Global Risks Report 2025,* Coulson-Thomas, C. (2025). Global risks and confronting insecurity and vulnerability. Management Services, 69(1), 21-28.
72. *Consulting.eu (https:*[*//www.consultancy.eu/news/8655/the-growing-importance-of-supply-chain-risk-management)*](http://www.consultancy.eu/news/8655/the-growing-importance-of-supply-chain-risk-management%29).
73. Queiroz, M. M., Telles, R., & Bonilla, S. H. (2020). Blockchain and supply chain management integration: a systematic review of the literature. *Supply chain management: An international journal*, *25*(2), 241-254.
74. Wang, Y., Singgih, M., Wang, J., & Rit, M. (2019). Making sense of blockchain technology: How will it transform supply chains? *International Journal of Production Economics*, *211*, 221-236.

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1. htps://laconteconsulting.com/2018/12/02/calculate-impact-and-probability/amp/