Supply Chain Risk Management: A Review

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Abstract

Supply chain risk management (SCRM) is pivotal in contemporary business operations, especially amid global disruptions like the COVID-19 pandemic. This abstract provides a synthesis of six research studies encompassing various facets of SCRM. The first study underscores SCRM's significance and introduces the Interpretive Structural Modelling (ISM) approach for assessing intricate relationships among supply chain risks. Demonstrating ISM through the RMK Food Products case study, it illustrates how this tool aids risk visualization and prioritization. The second study delves into sustainable supply chain management, emphasizing its role in achieving economic, social, and environmental objectives. It utilizes the automotive industry to exemplify the importance of evaluating sustainability risks for bolstering supply chain resilience. The third study lays the foundations of Healthcare Supply Chain Risk Management (HCSCRM), highlighting SCRM, supply chain resilience, supply chain management, clinical engineering, and High Reliability Organizations. It underscores healthcare's unique challenges and the need for tailored risk management. The fourth study discusses the COVID-19 pandemic's impact on supply chains, necessitating adaptive strategies. It explores responses in the automotive, PC, and home furnishings industries, emphasizing sector-specific resilience-building approaches. The fifth study offers a comprehensive SCRM analysis, covering risk definitions, typologies, management strategies, and tools. It accentuates the significance of risk detection and mitigation and identifies SCRM research trends. The sixth study categorizes supply chain risks into macro and micro types, providing a framework for disruption understanding. It identifies risk factors for each category and classifies SCRM methods into four processes, facilitating integration into the SCRM framework.

In conclusion, SCRM is indispensable in today's globalized and dynamic business environment. These studies collectively underscore the need to comprehend, assess, and mitigate supply chain risks across diverse industries. They offer valuable insights, guiding future research in the field, and contribute to the continuous improvement of supply chain resilience in an ever-changing world.

Keywords: Supply Chain Risk management, Covid-19, Food Products

Introduction

The history of global trade starts with the production of Rum, the supply chain in this case started with slaves who were moved from Africa to the Caribbean to grow the sugarcane, which came from India, and it ended in distilleries in the US. In late 1920's the introduction of large scale production along assembly line laid the foundation for supply chain management.

With the introduction of computers, the supply chain management significantly improved by using spreadsheets, optimization models and algorithms that could predict logistics issues for a supply chain. In the last 15 years due to the rise of social media, poor practices along the parts of supply chain have come

to the spot light. This has now created a global pressure to have an ethical and sustainable supply chain, analytics play an even more vital role in the supply chain management.

In today's dynamic business landscape, supply chain risk management has become a cornerstone of effective operations. It encompasses strategies and practices designed to identify, assess, and mitigate the risks that can disrupt the seamless flow of goods and services within complex supply chains. A fundamental aspect of this process is gaining a comprehensive understanding of the myriad sources of risk and their intricate relationships. While classic risk management techniques such as prevention, control, mitigation, diversification and risk pooling, continue to play a pivotal role in minimizing the impact of adverse events and uncertainties, this paper delves deeper into the multifaceted world of supply chain risk management.

This exploration extends beyond conventional approaches to introduce the practical application of risk management principles. By analysing scenarios, we highlight the strategies and tools that organizations can employ to prioritize risk mitigation effectively. The objective is to ensure the resilience and uninterrupted flow of goods and services within supply chains that are subject to ever-evolving challenges and uncertainties.

Literature Review
Supply chain Risk Management (2021)
This research paper delves into the multifaceted domain of supply chain risk management (SCRM) against the backdrop of the globalized world of international trade and supply chain management (SCM). The paper commences by highlighting the inherent risks in SCM and underscores their exacerbation due to globalization and trade openness. A central premise is established - the strength of a supply chain is directly proportional to the resilience of its weakest link, rendering the management of risks paramount.
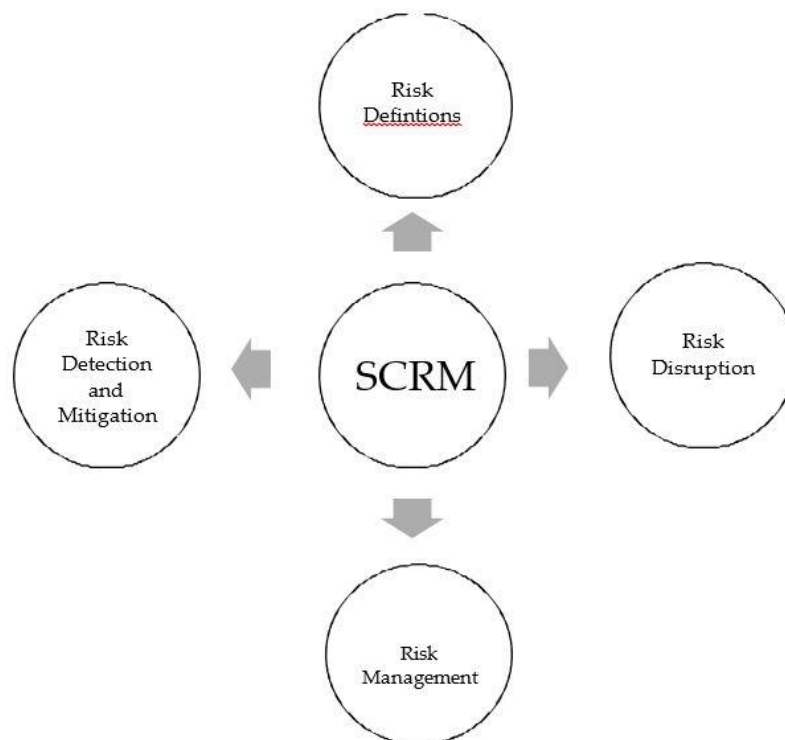

Figure 1. Supply chain risk management categories

The paper dissects the components of SCRM, starting with an exploration of diverse definitions of "risk" in various contexts and the evolution of SCRM definitions over time. Risk is contextualized as vulnerability, uncertainty, disruption, disaster, peril, or hazard, underscoring its multifaceted nature. The paper proceeds to dissect risk disruption, emphasizing the escalating scale and frequency of disruptive events that can compromise SCM. Various typologies for classifying risks in SCM are scrutinized, such as operational, network, and external risks.

Risk management takes center stage as the paper delves into strategies, methods and tools employed to identify and control risks in supply chains. The diverse strategies encompass prevention, rescheduling, conjecture, numerical and economic approaches, vertical integration, risk-sharing, and technology and security. Case studies are employed to illustrate these strategies' real-world applications and efficacy.

Risk detection and mitigation strategies are paramount in the context of SCRM. The paper emphasizes the importance of pre-disruption risk detection, underscoring its role in minimizing the impact of disruptive events. Diverse tools, including mathematical programming models, simulation models, analytical hierarchy processes, and complexity theories, are identified as instrumental in risk detection and mitigation.

The research paper then delves into the analysis and discussion of SCRM literature, highlighting the substantial body of research and its evolution over the years. The paper identifies trends, publication frequencies, and the prominence of top journals in the field.

Ultimately, the research implications of this comprehensive analysis are outlined. Key areas for future exploration include the development of risk recovery models, the integration of Industry 4.0 technologies into SCRM, and strategies for harmonizing different types of risk. The importance of strategic planning in the face of a volatile business environment is underscored, with recommendations for addressing uncertainties and disruptions in supply chains. The paper concludes by affirming the vital role of SCRM in the modern global supply chain ecosystem and the need for ongoing research to enhance supply chain resilience in the face of evolving risks.[1]

Supply Chain Risk Management (2015)

This research paper conducts an in-depth analysis of 224 international journal articles published between 2003 and 2013, focusing on the dynamic field of Supply Chain Risk Management (SCRM). The central contributions of this study encompass the elucidation of essential definitions, the meticulous categorization of supply chain risks, identification of key risk factors, method categorization for SCRM processes, and the illumination of critical research gaps. The research paper introduces a conceptual framework for categorizing supply chain risks, distinguishing between macro-risks and micro-risks. Macro-risks encompass rare external events, including natural (e.g., earthquakes) and man-made (e.g., terrorism) risks. In contrast, micro-risks arise from internal activities or relationships within the supply chain. Micro-risks consist of demand risk, manufacturing risk, supply risk, and infrastructural risk. Manufacturing risk pertains to internal factors affecting production quality and timeliness. Demand and supply risks relate to downstream and upstream partners, respectively. Additionally, risks associated with information technology, transportation, and financial systems are grouped as infrastructural risk, all of which can disrupt supply chains.[2]
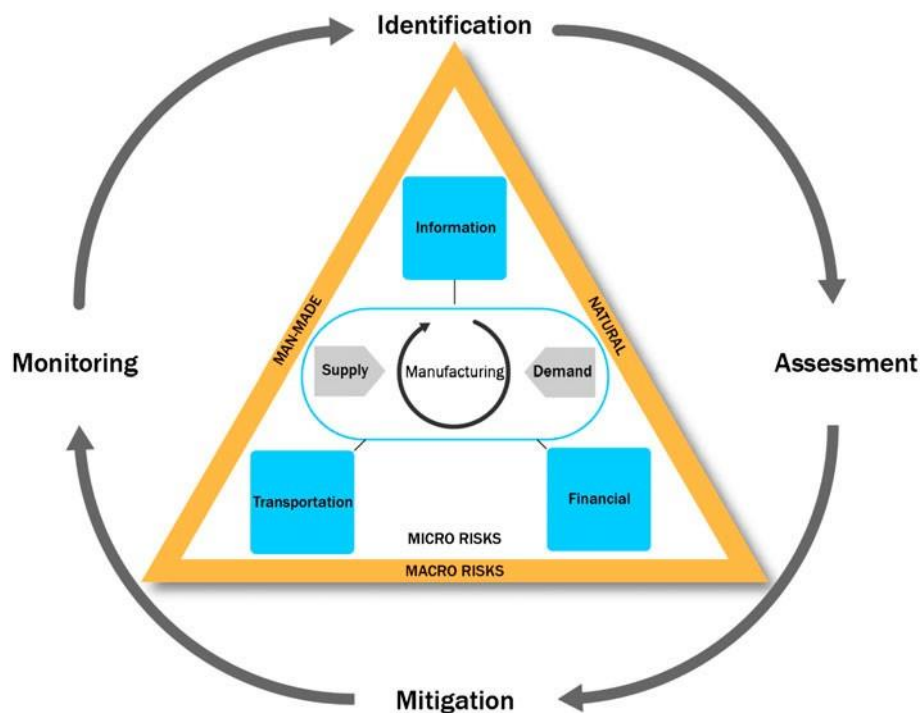
Figure 2. Conceptual framework of supply chain risks

This holistic perspective empowers supply chain professionals with a comprehensive toolkit to identify and navigate various potential disruptions effectively. In addition to the categorization of risks, this paper identifies potential risk factors associated with each of these five common risk types. This meticulous exploration serves as the cornerstone for the development of comprehensive supply chain risk index models. The resulting models provide practitioners with a robust mechanism for assessing, mitigating, and managing risks across the entire supply chain spectrum. Furthermore, the study categorizes SCRM methods into four major processes:

- **Risk Identification** is the initial step, involving the recognition of various supply chain risks using both qualitative and quantitative techniques.
- **Risk Assessment** evaluates the likelihood and consequences of risk events, with methods categorized into macro and micro assessments, especially in supply chain contexts.
- **Risk Mitigation** strategies are crucial in SCRM, addressing risks categorized into macro, demand, manufacturing, supply, transportation, financial, and information, aligning with the identified risk types.
- **Risk Monitoring** is a less-studied aspect. Zhang et al. (2011) devised a model using fuzzy set theory and neural networks for pre-warning signals in food supply chain quality, effectively detecting abnormalities, albeit without real data validation and focusing solely on quality risk.

However, most studies have leaned towards qualitative methods without quantifying risk impact. This categorization not only facilitates the selection of appropriate methods but also streamlines the integration of these methods into the broader SCRM framework. Lastly, the research unveils ten pivotal research gaps within the SCRM domain and proposes potential research directions. These gaps highlight areas where further investigation is needed and offer valuable guidance for scholars aiming to contribute to this evolving field. Addressing these gaps holds the potential to enrich our understanding of SCRM and enhance the effectiveness of supply chain risk management practices in a rapidly evolving global landscape.[2]

Supply Chain Risk Management : Healthcare (2021)

The field of Healthcare Supply Chain Risk Management (HCSCRM) has gained increasing attention in recent years due to the unique challenges posed by healthcare supply chains. While Supply Chain Risk Management (SCRM) has been widely studied in various industries, its application to the healthcare sector has distinct characteristics that demand specialized attention. This literature review aims to explore the foundations of HCSCRM and its key pillars, including Supply Chain Risk Management, Supply Chain Resilience, Supply Chain Management, Clinical Engineering, and High Reliability Organizations.[3]

Supply Chain Risk Management is the cornerstone of HCSCRM. SCRM involves the systematic identification, assessment, mitigation, and monitoring of risks within the healthcare supply chain. Norrman and Jansson (2004) laid the groundwork by defining SCRM and proposing measures for risk identification and mitigation. However, as noted by Sodhi et al. (2012) and Baryannis et al. (2019), there is still no universally accepted definition of SCRM. This lack of consensus emphasizes the complexity of SCRM in healthcare settings, where the primary goal is not profit but patient care. Despite the absence of a precise definition, HCSCRM has demonstrated its potential to enhance various dimensions of healthcare supply chains, such as budget consistency, reliability, flexibility, and the control of the bullwhip effect (Elleuch et al., 2013). Notably, healthcare supply chains, which encompass a vast array of medical devices and equipment, face unique challenges that require specialized risk management strategies.

Supply Chain Resilience:

Supply Chain Resilience plays a crucial role in HCSCRM. Resilience involves the ability of the healthcare supply chain to withstand disruptions and recover swiftly. It encompasses various constructs, including Total Quality Management (TQM), Total Productive Maintenance, trust, cooperation, supply chain connectivity, visibility, information sharing (Dubey et al., 2019), and emerging technologies like Supply Chain 4.0 and blockchain (Ivanov and Dolgui, 2020). Resilience is particularly essential in healthcare supply chains due to the criticality of patient care and the potential life-threatening consequences of supply disruptions.
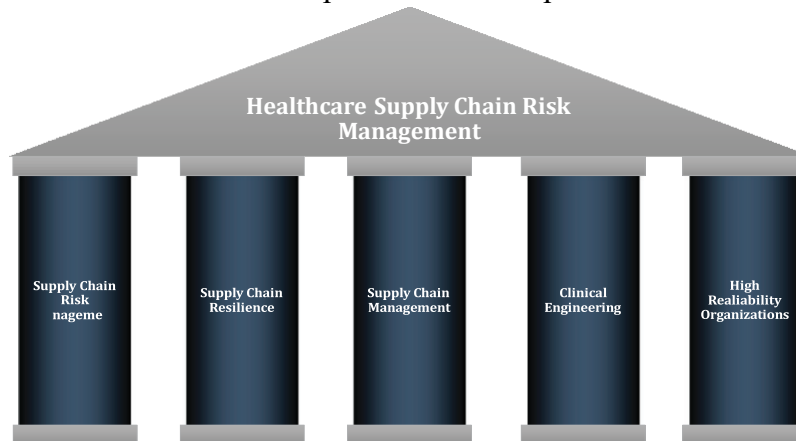
Supply Chain Management (SCM):

Supply Chain Management is a fundamental pillar of HCSCRM. It entails the integrated management of the entire healthcare supply chain, from procurement to distribution. Practices like Total Quality Management (TQM) and Lean principles, including value stream mapping and failure mode and effect analysis (FMEA), are essential tools for optimizing healthcare supply chains. Efficient SCM ensures that the right medical devices and supplies are available when needed, contributing to patient safety and risk mitigation.

Clinical Engineering:

The term clinical engineering is used to denote engineering involved in the hospital setting. Clinical Engineering is a critical component of HCSCRM, focusing on the management and maintenance of medical devices and equipment. In the context of HCSCRM, clinical engineers play a vital role in ensuring the reliability and safety of medical equipment, thereby minimizing patient care risks. With the healthcare sector relying on a wide variety of medical devices, effective clinical engineering practices are essential to identify, assess, and mitigate potential risks associated with equipment failures or malfunctions.

High Reliability Organizations (HROs):

High Reliability Organizations (HROs) are entities that prioritize safety, reliability, and error reduction in high-risk environments. While not explicitly mentioned in the literature, the principles of HROs are highly relevant to HCSCRM. Healthcare facilities, by their nature, operate in high-risk environments, where patient safety is paramount. Applying HRO principles to healthcare supply chains can enhance their resilience and minimize risks associated with patient care disruptions.

Figure 3. HSCM Constructs

HCSCRM is an evolving field with unique challenges and opportunities. It encompasses Supply Chain Risk Management, Supply Chain Resilience, Supply Chain Management, Clinical Engineering, and principles of High Reliability Organizations. While the healthcare sector has distinct characteristics, the application of SCRM principles and the adoption of resilience-building practices are essential to ensure the quality and continuity of patient care. Further research and empirical studies are needed to develop specialized HCSCRM frameworks and strategies tailored to the healthcare industry's specific needs. The integration of these pillars provides a comprehensive approach to addressing the complexities and risks inherent in healthcare supply chains, ultimately enhancing patient outcomes and safety.[3]

Supply Chain Management in the Food Industry (2012)

Supply chain risk management is a critical facet of contemporary business operations. It encompasses strategies and practices aimed at identifying, assessing, and mitigating risks that can disrupt the smooth flow of goods and services within a supply chain. One fundamental aspect of effective risk management is the understanding of various sources of risk and their intricate relationships. Classic risk management techniques include prevention, control, mitigation, diversification, and risk pooling. These strategies play a pivotal role in minimizing the impact of adverse events or uncertainties.[4]

One prominent tool in supply chain risk management is the Interpretive Structural Modeling (ISM) approach. ISM is a powerful method for assessing the complex relationships among different risk factors within a supply chain. Developed as a communication tool for complex situations, ISM has found applications in diverse domains, including policy analysis and management research. It aids in transforming vague, poorly articulated models of systems into clear, well-defined models, thus enhancing decision-making processes.

In the context of supply chain risk management, ISM assists in structuring and visualizing the risks involved. It begins by listing and categorizing the various risks associated with a specific supply chain. These risks can range from macro-level external factors like natural disasters and political instability to more granular issues such as demand fluctuations and supply disruptions. Once identified, ISM establishes

relationships among these risks, allowing for the creation of a Structural Self-Interaction Matrix (SSIM). The SSIM employs symbols like 'V' for one risk helping alleviate another, 'A' for one risk being alleviated by another, 'X' for reciprocal alleviation, and 'O' for no relation.

From the SSIM, a Reachability Matrix is derived, reflecting the directional relationships between risks. This matrix is then analyzed, and risks are classified into different levels based on their interdependencies, adhering to the transitivity rule. Risks classified as autonomous, dependent, linkage, or driver/independent provide valuable insights into their roles and impact within the supply chain. This categorization informs risk mitigation strategies, allowing organizations to prioritize their efforts effectively.

In practical application, the case study of RMK Food Products, a leading South Indian food manufacturer is provided. This company's intricate supply chain involves sourcing raw materials from multiple suppliers, distributing products through an extensive network of distributors and retailers within the state. Risks identified in this supply chain span macro-level external factors, demand fluctuations, supply challenges, product/service management issues, and information management uncertainties. Implementing the ISM model allowed RMK Food Products to visualize the interplay of these risks and prioritize risk mitigation strategies effectively, particularly emphasizing the management of product/service management risk to ensure the resilience and continuity of its supply chain operations.

In conclusion, supply chain risk management is essential in today's dynamic business landscape. The ISM model, with its ability to uncover and visualize the intricate web of supply chain risks, empowers organizations to make informed decisions and implement robust risk mitigation strategies, ultimately ensuring the resilience and continuity of their supply chain operations.[4]

Supply Chain sustainability and risk assessment (2019)

For many companies in various industries, supply chain management is one of the most important tasks in their daily operations and long-term planning. A supply chain involves multiple stakeholders including multi-tier suppliers and customers often located in different locations. In addition to business performance of the supply chain (e.g., efficiency, timeliness, stability), environmental and social implications of the supply chain have been increasingly perceived as integral parts of supply chain performance by stakeholders. Subsequently, sustainable supply chain management—managing the supply chain to meet the economic, social, and environmental triple bottom line—has become increasingly relevant for business managers and stakeholders.[5]

Unlike traditional supply chain management, sustainable supply chain management aims to meet economic, social, and environmental triple bottom line across the entire supply chain for multiple stakeholders. An increasing number of studies have developed theoretical frameworks and analyzed empirical cases to evaluate and improve the economic, social, and environmental performance of supply chains. Empirical studies have also investigated supply chain sustainability in many industries including the automotive industry. The research paper emphasizes the choice of the automotive industry as a representative example of a broad-structure supply chain. This decision is based on the complexity inherent to the automotive supply chain, which involves the simultaneous availability of multiple components crucial for automotive manufacturing and assembly. These studies provide important tools and insights on the evaluation of supply chain sustainability and decision support to improve supply chain sustainability.

One important component of supply chain management is to assess the risk posed by both external and internal factors to the stability and efficiency of the supply chain. Similarly, sustainable supply chain

management also involves the assessment of supply chain sustainability risk. In particular, supply chain sustainability risk means a potential sustainability-related condition or event that can provoke harmful stakeholder reactions within the supply chain. Understanding supply chain sustainability risk can help companies improve the resilience of supply chains. Given the increasing concerns on sustainability and globalized supply chains in many industries, it is crucial to provide a complete picture of supply chain sustainability risk to allow business managers and stakeholders to make informed decisions for not only improving supply chain sustainability but also mitigating supply chain sustainability risk. Knowledge of supply chain sustainability risk scatters in the literature across many disciplines. This study develops an integrated framework to assess supply chain sustainability risk for a company or industry. The supply chain sustainability risk in this study comprises all three aspects of sustainability, including operational (economic) risk, social risk, and environmental risk.

This study divides the apparel supply chain into six stages including raw material production, fiber production, spinning, weaving, dyeing, and tailoring. Operational risk assessment results identify the dyeing stage as having the highest operational risk among all six stages for the apparel supply chain. The highest operational risk in dyeing comes from its high demand risk and corporate-level risk. Social risk scores of these 23 countries/regions are assessed. Social risk scores of major locations of the tailoring stage are higher than 50 out of 100 maximum. Environmental risk assessment points to dyeing as the most environmentally risky stage, primarily due to water pollution from dye use.

The global automotive supply chain is divided into six stages: engine, body shell, transmission, tire, electric system, and assembly. The engine manufacturing stage has the highest operational risk, driven by demand volatility, corporate-level challenges, and intellectual property risks. Social risk analysis singles out assembly as having the highest social risk, particularly in developing countries. Environmental risk is prominent in engine manufacturing due to the environmental implications of aluminum-based components.

This research paper contributes significantly to the realm of sustainable supply chain management by introducing an integrated framework for assessing supply chain sustainability risk across the triple bottom line. It offers valuable insights into managing supply chain sustainability risks, particularly within the unique context of the automotive sector.[5]
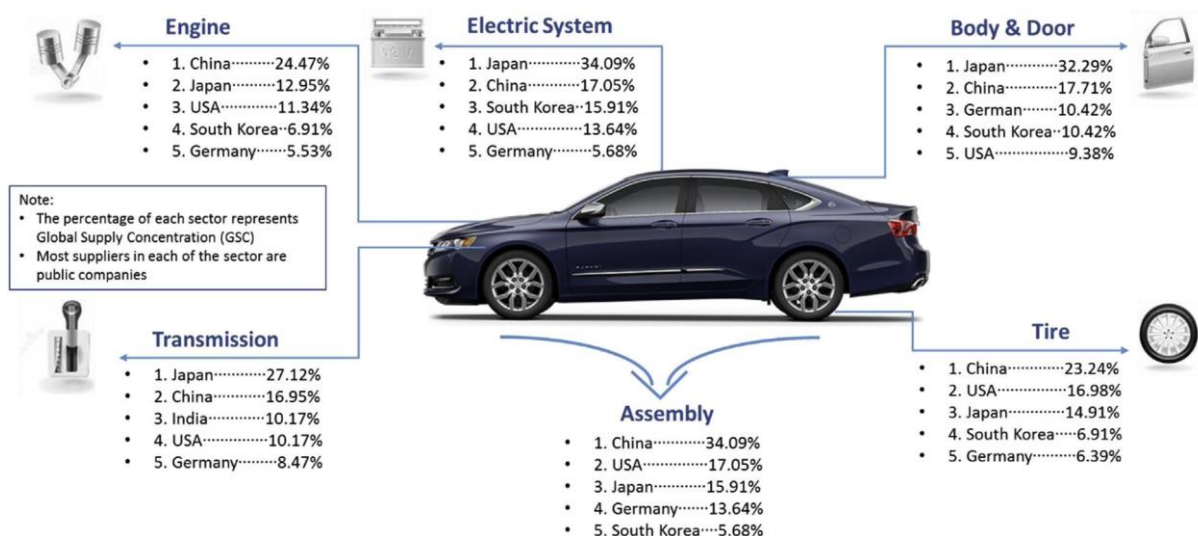

Figure 4. Supply chain mapping for global automotive industry

Supply Chain Management during and post pandemic (2020)

The global COVID-19 pandemic has brought about an unparalleled crisis that extends beyond public health, significantly affecting social, economic, and commercial systems. With projections from the World Bank indicating a stark -5% contraction in the global economy for 2020, and with a particularly harsh impact on developing nations, businesses worldwide are grappling with challenges beyond reduced consumer demand; supply chain disruptions have been a defining feature of the pandemic. In this context, the imperative to reevaluate supply chain strategies and adapt them for resilience in the post-pandemic world is increasingly evident. Shuichi Ishida's paper offers a comprehensive exploration of the intricate art of managing product supply chains amidst the turbulent backdrop of a pandemic, drawing critical insights from the automotive, personal computers (PCs), and home furnishings industries.[6]

One of the paper's central revelations lies in the nuanced and contrasting responses witnessed across diverse industry sectors. For instance, the automotive industry is currently in the throes of a significant transformation, trending toward centralized supply chain management. This strategic shift, in essence, leverages the sector's closed-integral structure, as automotive companies increasingly prioritize proximity to production facilities. The impetus for this transition can be traced to the industry's vulnerability when production sites in China suddenly ceased operations, subsequently triggering a domino effect of disruptions globally. To fortify resilience, automotive corporations are actively exploring the establishment of regional logistics hubs. Conversely, the PC industry, characterized by extensive global supply chains, confronts the formidable challenge of reducing its dependence on specific countries, notably China. Notably, companies such as Apple have showcased resilience during the pandemic, underlining the significance of dynamic capabilities and a robust network of localized suppliers. This underscores the imperative of finding an equilibrium between global and local sourcing within the PC industry. Furthermore, the home furnishings sector, epitomized by Nitori, has deftly navigated the pandemic storm through the vertical integration of its global supply chain. Nitori's approach effectively merges centralized control with rigorous quality standards, allowing for swift recovery even amid the pandemic's turmoil. This serves as a potent example of the potential efficacy of varying degrees of "closed modularity" in bolstering supply chain resilience, with the extent of closure calibrated in response to industry-specific dynamics.

In conclusion, Ishida's paper emerges as a lodestar guiding us through the intricate landscape of supply chain management in a post-COVID-19 world. It underscores the pivotal role of adaptability, dynamic capabilities, and a custom-tailored approach to supply chain management that artfully considers sector-specific idiosyncrasies. As the world grapples with the ever-evolving challenges posed by global disruptions, the ability to reimagine and recalibrate supply chains stands as an indispensable facet of business resilience in the post-pandemic era. In essence, Ishida's paper transcends the realm of academia, emerging as an indispensable tool for practitioners navigating the complex, uncertain terrain of supply chain management in an era defined by change and unpredictability.[6]

Conclusion

In conclusion, the analysis of these six research papers on supply chain risk management (SCRM) reveals several key insights and trends in the field:

Diverse Applications of SCRM: The papers collectively demonstrate that SCRM is a versatile field applicable across various industries, including automotive, healthcare, international trade, and more. It emphasizes the critical role of SCRM in ensuring the resilience and continuity of supply chain operations.

- **Integrated Approaches**: A common theme across the papers is the importance of integrating different aspects of SCRM. Whether it's combining supply chain management with clinical engineering in healthcare or balancing global and local sourcing in international trade, an integrated approach is crucial.

- **Risk Categorization**: Several papers categorize risks within supply chains, differentiating between macro and micro risks or assessing risks based on economic, social, and environmental factors. This categorization helps in identifying and managing specific risks effectively.

- **Methods and Tools**: The research papers highlight a variety of methods and tools for SCRM, ranging from mathematical models to qualitative assessments. These tools aid in risk identification, assessment, mitigation, and monitoring.

- **Resilience**: Supply chain resilience emerges as a recurring theme. Resilience is essential for withstanding disruptions and ensuring the continuity of operations, especially in healthcare and international trade.

- **Future Research Directions**: The papers collectively identify research gaps and suggest areas for future exploration. These gaps include risk recovery models, the integration of Industry 4.0 technologies, harmonizing different types of risk, and improving risk monitoring.

- **Complexity and Uncertainty**: The evolving global landscape, as exemplified by the COVID-19 pandemic, highlights the complexity and uncertainty inherent in supply chains. Adaptable and dynamic strategies are crucial for effective SCRM.

In summary, these research papers underscore the importance of supply chain risk management in today's interconnected and unpredictable world. They provide valuable insights, tools, and frameworks for practitioners and researchers to enhance supply chain resilience and mitigate the impact of disruptions across various industries. As supply chains continue to evolve, SCRM remains a critical area of study and practice.

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