RISK, RESILIENCE AND CONTINUITY IN SUPPLY CHAIN MANAGEMENT: A REVIEW

Abstract

Supply chain risk management (SCRM) assists in minimizing disruptions and vulnerabilities arising from various internal and external factors, such as operational, environmental, and geopolitical risks. This study attempts to describe various concepts and challenges related to SCRM. It aimsto assess how supply chain service quality and trade network economic metrics are impacted by risk events and unstable conditions.The findings suggest that supply chain disruptions, demand – supply imbalance, and lack of managerial ability are primary challenges for (SCRM). The studyprovides valuable insights to the retailers in the formulation of the strategies related to the supply chain risk management. We believe that risk management in supply chains is becoming more complicated, and to make order wise managerial choices, tools that integrate analytical and optimization techniques together with simulation modeling must be continuously improved.

Keywords: Supply chain, supply chain risk management, supply chain resilience, supply chain agility, operational performance

1. INTRODUCTION

Supply chains (SC) are conceptualized as intricate networks of entities engaged through both upstream and downstream interconnections to execute various functions that generate value for the ultimatecustomers in the shape of products and services.Modern SCs are meticulously structured to provide products in appropriate quantities- at designated locations, at precise times, and in the most efficient manner possible. It is crucial to recognize that SCsdo not constitute mere linear sequences or procedures but represent multifaceted networks. The ever-evolving nature of international markets, marked by rigorous regulatory demands and an increasingly aware consumer demographic, compels the reassessment of conventional supply chain methodologies to adopt more sustainable and ethically responsible frameworks (Abiona et al., 2024; Quarshie et al., 2015).

Trade between nations establishes worldwide SCs, and supply chain management (SCM) entails inherent hazards.Modernization and increasing trade liberalization have raised risks and made SCM more sensitive. Risk management constitutes the systematic endeavor of devising and

executing plans and strategies aimed at overseeing supply chain networks, primarily by mitigating vulnerabilities and performing ongoing risk evaluations to ascertain the resilience of supply chains. According to Garvey et al. (2014), risk in a SC is "the possibility of an unfavorable and unforeseen circumstance that could cause a supply chain disruption either directly or indirectly." Nonetheless, risk and disruption are two different things. Within the context of SCs, disruption serves as an indicator of potential peril. However, hazards are present even in the absence of interruption.

SCM risks include globalization, shorter product lifecycles, worldwide trade networks, market volatility, cost restrictions, outsourcing, and offshore production (Hachicha&Elmsalmi 2013; Lavastre et al., 2012). Globalization and countries' economic connections with one another have changed global production processes. These complexities have rendered supply chains more intricate and susceptible to a wider array of threats. Organizations have established production facilities, warehouses, and factories, and fulfillment centers across nations to obtain cost advantages, access to less expensive sources of raw materials, or specialized knowledge and skills (Choi et al., 2012).

All supply chains are susceptible to possible disruptions in the current unstable and unpredictable business climate. From man-made crises, such as cybersecurity attacks and financial meltdowns to natural disasters like hurricanes, earthquakes, and pandemics, supply chain interruptions can result in large financial losses and strained relationships.To lessen these negative supply chain effectsbusinesses must build robust supply chains. Ponomorov and Holcomb (2009) defined supply chain resilience (SCRES) as- “The SC's flexible ability to foresee unanticipated events, respond to disruptions, and recover from them by maintaining operations at the proper level of connectedness and control over structure”.

The systematic and recurring framework of supply chain risk management (SCRM) incorporates the processes of identifying, evaluating, prioritizing, mitigating, and monitoring potential disruptions within the supply chain (Aqlan& Lam, 2016).

In essence, supply chain risk management (SCRM) ensures that goods and services are delivered to customers smoothly while minimizing negative effects on the business. It does this by enabling companies to recognize, evaluate,minimize any possible interruptionswithin their SCs, protecting their operations, reputation, and financial performance by preventing issues like stockouts, delays, quality problems, and reputational damage that could arise from unforeseen

events , such as natural disasters, geopolitical instability, or supplier failures. Peng (2024) emphasizesd the need of anticipating potential dangers and opportunities, monitoring market trends, establishing effective communication channels, and developing early warning systems.

Effective risk management and supply chain resilience are essential for corporate success and performance. Effective risk management approaches have a substantial impact on supply chain resilience, providing an option between disruptive events and operational implementations. Additionally, lowering disruptions and turbulence in the workplace requires enhancing supply chain resilience (SCR) and agility (SCA) (Ivanov & Das, 2020; Zhao et al., 2023).Supply chain agility is a developing quality required to succeed in a cutthroat environment by implementing creative organizational strategies (Brusset, 2015).SCR is a supply chain's capacity to foresee, adjust to, guaranteeingconsistencyor reducing negative effects of interruptions on business execution (Li et al., 2023). This study provides valuable insights for firms to build a solid system that supports strategic management in the face of unexpected market conditions.

The current study is a comprehensive literature review that focuses attention on existing reviews regarding the challenges marketers encounter while managing the risk related to SC in the marketplace. This study includes various research articles from high-quality journals and reputed databases, such as Taylor & Francis, Emerald, Springer, Google Scholar, and Research Gate. The keywords used to find articles were - supply chain, risk management, supply chain resilience, supply chain agility and operational performance.

Objective:

The primary aim of this paper is to explore the role of supply chain risk management (SCRM) practices in minimizing supply chain disruptions and supporting organizations in enhancing supply chain resilience and operational performance.

Methodology:

This study uses a review-based methodology to assess current understanding of supply chain risk management (SCRM), supply chain resilience (SCRES), supply chain agility (SCA), and operational performance. The review aims to identify the key concepts, theoretical developments, major risk factors, risk management practices, and emerging research trends within the domain of SCRM.

An extensive search of the literature was conducted using internationally recognized academic databases, including Taylor & Francis Online, Emerald Insight, SpringerLink, ResearchGate, and

Google Scholar. Peer-reviewed journal articles published primarily in the fields of SCM, logistics, operations management, and risk management were considered. The search was performed using combinations of the following keywords: supply chain, supply chain risk management, supply chain risk, supply chain resilience, supply chain agility, operational performance, supply chain disruptions, and risk mitigation.

Peer-reviewed studies on SCRs, resilience, agility, and operational performance were included in the review.A total 80 articleswere chosen which were reduced to 61 after excluding the studies unrelated to supply chain management, conference abstracts, editorials, book reviews, duplicate publications, and articles lacking sufficient methodological information.

Table 1: Inclusion and Exclusion Criteria

Criteria	**Inclusion Criteria**	**Exclusion Criteria**
Topic	Studies related to supply chain management and SCRM	Studies not addressing supply chain management and risk management
Accessibility	Only full-text articles	Articles without full text
Document type	Peer-reviewed, empirical studies, book chapters	Conference papers, dissertations, notes, or any other short communications
Language	Articles in English only	Articles in other languages

After applying these criteria, 19 articles were excluded due to duplication, insufficient relevance, resulting in a final sample of 61 articles for detailed review.

2. LITERATURE REVIEW

2.1 Risk Management

"Risk management refers to techniques, procedures, and auxiliary tools for identifying and reducing risk to a manageable level." (Alhawari et al., 2012). Furthermore, a synchronized collection of methods and actions to guide a company to lower risk in order to accomplish its objectives can also be called risk management. Managers receive assistance from risk management in evaluation and comprehension of impact of risk which can be managed through cost effectiveness. By estimating risk, supply chain resilience may be increased, harm can be minimized, and risk management can be improved. Operational cost could be reduced by

providing flexibility in response to the rapidly changing and competitive marketplace. Organizations that plan for disturbances are able to recover quicker and have an edge over their competitors (Sheffi, 2005).

2.2 Supply Chain Resilience

Resilience is derived from the Latin term resiliere, which translates to the act of rebounding. As articulated by Christopher and Peck (2004), the fundamental principle of resilience posits that a system possesses the ability to revert to its initial state following a disruption. In the view of Weick and Sutcliffe (2001), resilience serves as a mechanism that not only anticipates but also continuously responds to external adversities. The concept of resilience is shared by many disciplines in that it aids in the management or adjustment to any changes or disruptions that occur in a system. Resilience refers to a system, group, or society's ability to adjust to potential threats and preserve acceptable functioning and structure. The social system's ability to learn from prior disasters and enhance risk reduction strategies determines its level of resilience. Resilient firms take proactive measures to overcome challenges and recover faster. Two components make up resilience: robustness, which is proactive, and agility, which is reactive (Braunscheidel & Suresh, 2009; Shukla et al., 2011). Nevertheless, resilience encompasses more than mere recovery; it necessitates a significant level of flexibility and adaptability in response to both advantageous and detrimental environmental influences. Supply chain resilience encompasses a range of threats throughout the risk management continuum within the SC analytical framework. To effectively manage supply chain risks, it is important to consider the perspective of resilience and how it may be integrated into the overall framework.

2.3 Supply Chain Agility

The capacity of a company to gain a competitive advantage by skillfully adapting to unpredictable market conditions is known as supply chain agility, or SCA (Blome et al., 2013).It assists businesses in managing supply chain disruptions effectively and economically. The relationship between SCA and supply chain performance (SCP) has been the subject of several research (Fosso Wamba & Akter, 2019; Gligor et al., 2016).Eckstein et al. (2014) claim that by closing the supply-demand gap, SCA can help businesses reduce inventory and transportation costs.SCA fosters changes to operating procedures, allows resource reconfiguration, and improves an organization's sensing capability, according to Gligor et al. (2016). Bernardes and Hanna (2009) assert that "rapid system reconfiguration in the face of unforeseen changes" is the

core of agility."SCA is the capacity to swiftly adjust to changing market conditions, customer demands, and unanticipated events (Ambulkar et al., 2015; Cadden et al., 2022).The concept of speed is intrinsic to agility; it is essential for promoting flexibility and competitiveness in erratic marketplaces(Gligor et al., 2016; Wamba et al., 2019).

2.4 Supply Chain Risk Management

Modern supply chains function in an unpredictable environment due to factors like fluctuating demand, frequent modifications to product designs and technological advancements, etc. This increases the supply chain's vulnerability, putting pressure on SC managers to deliver the product in a cost-effective manner within a specified delivery date in the proper amount, quality, and location. With SCRM, a company can react to supply chain disruptions more rapidly and effectively. Juttner et al. (2003) articulateSCRM is defined as "the identification and management of risks for the supply chain, through a coordinated approach among supply chain members, to reduce supply chain vulnerability as a whole." The conceptual architecture of risk management is partitioned into four distinct phases: risk identification, risk assessment, risk treatment, and risk monitoring. This conceptual framework divides the SCRM literature into four areas. The following are briefly explained:

2.4.1 Risk Identification

Kern et al. (2012) define risk identification as identifying all relevant risks and anticipating future uncertainty for proactive risk management. Identifying a risk is crucial for successful management of SCRs (Neiger et al., 2007).Subsequently, risk management efforts begin. Enyinda et al. (2009) claim that early detection of risks is critical for assessing whether a risk is significant and necessitates further evaluation or mitigation. To effectively identify possible supply chain threats and vulnerabilities, a comprehensive strategy is necessary (Kern et al., 2012). The erratic nature of risks, coupled with inadequate evaluation of their impacts, culminates in detrimental effects on the operational efficacy of the SC. To mitigate the risk associated with SC, SC managers need to identify and classify them. Abdel-Basset (2019) classified risk in two categories-internal risks (managed risks) and external risks (uncontrolled risks). Internal supply chain hazards originate within the supply chain and impact it internally. These hazards can be detected and mitigated with comparably little effort. Implementing SCRM initiatives early on can mitigate the impact of internal risks. The risk that emerges outside the SC

is termed as external risk, including environmental risks. Although rare, these unpredictable hazards can disrupt the supply chain at any point.

2.4.2 Risk Assessment

Efficient SCRM necessitates a fast and economically feasible SCR analysis (Zsidisin et al., 2004). Cohen and Kunreuther (2007) propose that hazards can be evaluated using facts, judgment by experts, and situations. Zsidisin et al. (2004) assert that risk assessment can be categorized as formal, informal, quantitative, or qualitative. Gaudenzi and Borghesi (2006) further assert that the evaluation of risk is fundamentally subjective, shaped by diverse interpretations of what constitutes a risk, alongside the complexities of both upstream and downstream interactions.

When evaluating risk, the SCR prioritization factor should be addressed. Prioritizing risks allows firms to determine the most significant dangers. Risks with a high impact or immediate mitigation may be prioritized (Sinha et al., 2004). Establishing and carrying out risk-reduction operations demands significant investment, and businesses may struggle to handle all potential threats. Prioritizing risks assists businesses in managing their limited resources for risk management (Zsidisin et al., 2004).

2.4.3 Risk treatment

The scholarly literature employs a diverse lexicon to delineate the various types of risk treatment methodologies that are available; the five fundamental risk management categories are as follows - The methodologies employed for managing risk encompass acceptance, avoidance, transfer, sharing, and mitigation. An extensive corpus of scholarly inquiry is devoted to the investigation of strategies aimed at risk reduction.

2.4.3.1 Risk acceptance

At present, there are no standardized protocols for determining the level of risk that an organization should be willing to tolerate. The tolerable amount varies based on the environment and risk propensity, which is an individual's or organization's willingness to take risks and accept unpredictability while making decisions (Park et al., 2016). However, the simple recognition of a risk does not suggest that it ought to be ignored. Continuous monitoring is necessary to prevent the identified outcomes from deteriorating (Aqlan& Lam, 2015). When the ramifications of risks surpass a specified threshold, it becomes imperative for organizations to explore strategies for mitigating, transferring, sharing, or otherwise diminishing the risk.

2.4.3.2 Risk avoidance

Risk mitigation is the prevention of prospective risks (Ritchie & Brindley, 2007). Owing to uneven supply, a firm may discontinue specific commodities, suppliers, or geographic markets (Hajmohammad& Vachon, 2015; Juttner et al., 2003).Organization addressthe root cause of the threat (Aqlan& Lam, 2015).

2.4.3.3 Risk transfer

As defined by Diabat et al. (2011), risk transfer is the assignment of obligations to another party. Zhen et al. (2016) propose that insurance for business interruption be used to transfer these risks. Risk transfer is particularly pertinent for disruptive risks that exert significant impact, such as natural disasters and acts of terrorism, instead of operational risk factors that possess a high likelihood yet minimal consequences (Aqlan& Lam, 2015).

2.4.3.4 Risk sharing

Splitting risks requires a different individual bear some or all of the risk. Entities may mitigate risk exposure by embedding clauses within contracts that accommodate anticipated alterations in related risks (Buzacott& Peng, 2011) and fostering collaborative relationships (Camuffo et al., 2007). Organizations might engage in advance ordering to alleviate risks related to inventory management due to financial constraints (Lai et al., 2009) or amplify production levels when consumer demand is reliably confirmed (Scheller-Wolf & Tayur, 2009). Risk sharing, like transferring risks, can save costs while improving customer service by tackling low-probability, high-impact threats (Lai et al., 2008).

2.4.3.5 Risk mitigation

As stated by Norrman and Jansson (2004), it applies to minimizing the likelihood and severity of risk events. Choosing a risk mitigation strategy is determined by the type of risk and the organization's budget (Schoenherr & Tummala, 2011). Before making a decision, organizations should carefully assess the options for acceptance, avoidance, sharing, and transfer.

2.4.4 Risk monitoring

The risk is a dynamic phenomenon. Continuous monitoring is required to identify risk factors and alter treatment strategies as necessary. This is vital to ensure that monitoring the risk does not rely entirely on subjective assessments. Zsidisin (2003) emphasized the need for formal processes including updating and monitoring SCRM progress, managing changes, and acquiring new data.

2.5 Challenges in Supply Chain Management

2.5.1 Technological Implementation Barriers

Despite the benefits of digitalization, many organizations struggle to integrate modern technologies because of high investment costs, a lack of experience, and integration concerns with previous systems (Gunasekaran et al., 2016). Strategic planning, personnel training, and change management are all necessary for successful technology adoption (Saberi et al., 2018).

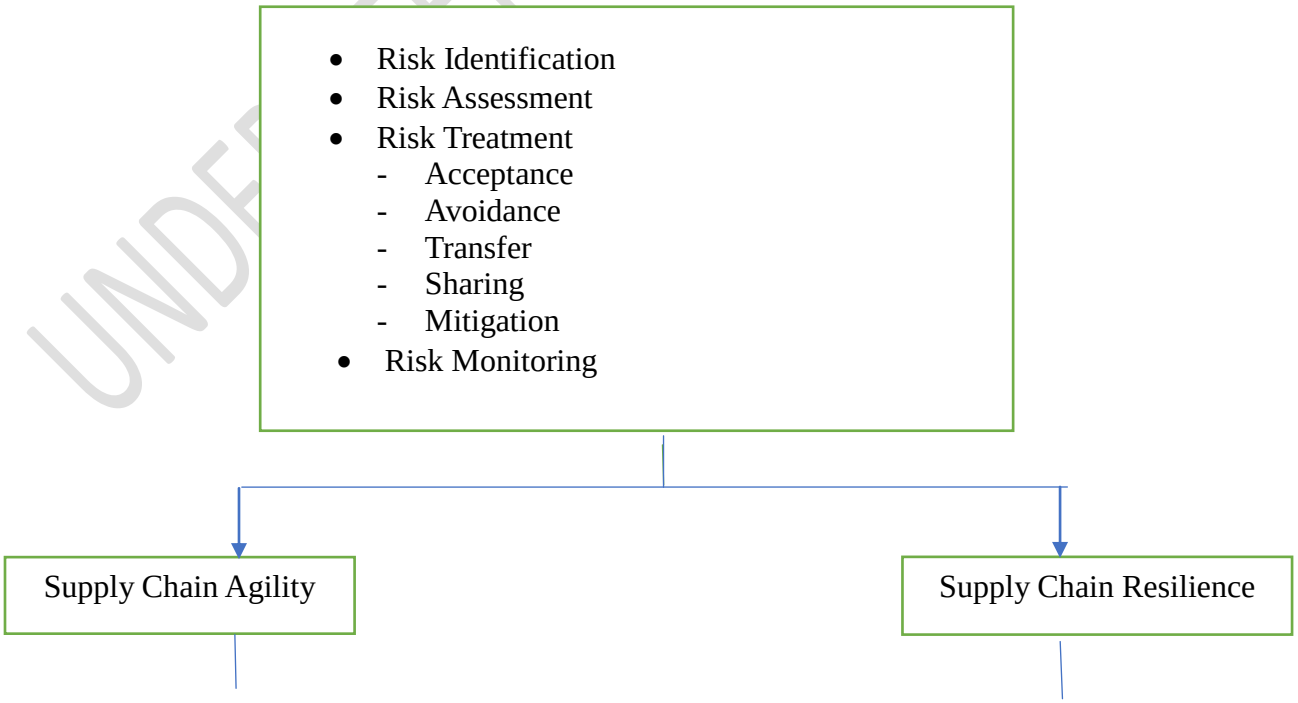
2.5.2 Cost Pressures and Efficiency Trade-offs

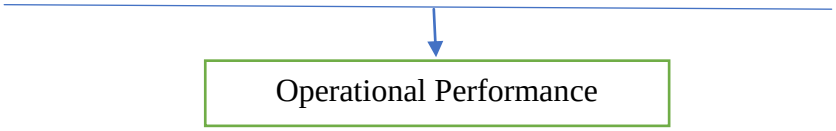
Supply chain managers continue to face the challenge of balancing cost reduction with service quality and responsiveness (Christopher & Holweg, 2011). Although lean manufacturing and just-in-time (JIT) inventory procedures are cost-effective, they may increase vulnerability to supply chain interruptions (Blackhurst et al., 2005).

2.5.3 Regulatory and Compliance Issues

Companies operating in several countries must manage complex regulatory structures involving trade regulations, tariffs, and environmental norms (Gereffi& Lee, 2012). Compliance with industry standards, such as the General Data Protection Regulation (GDPR) and environmental sustainability legislation, complicates supply chain operations (Kleindorfer et al., 2005).

Conceptual framework of Supply Chain Riak Management:





(Figure1)

The conceptual framework of the study, as shown in Figure 1, highlights that the core concept is supply chain risk management (SCRM), which consists of four interconnected processes:

1. Identification of Risk
2. Evaluation of Risk
3. Risk Management (acceptance, avoidance, transfer, sharing, and mitigation)
4. Risk Assessment

Organizations can recognize supply chain concerns and take proactive measures by using these techniques. When SCRM is implemented well, an organization's supply chain resilience- which measures its capacity to anticipate, respond to, and recover from unforeseen disruptions-is strengthened while its supply chain agility is improved, allowing for quick adaptation to shifting market conditions and disruptions. By guaranteeing business contuinity, lowering disruption-related losses, boosting flexibility, improving delivery reliability, and boosting overall supply chain efficiency, agility and resilience work together to improve operational performance.

3. RESEARCH GAP

Despite the increasing amount of research on supply chain risk management (SCRM), there are still a number of unanswered questions in the literature. The integration of risk identification, risk assessment, risk treatment, and continuous risk monitoring as an interconnected process has received relatively little attention, whereas a large portion of the literature looks at supply chain hazards and specific risk-management techniques independently. Additionally, although supply chain agility and resilience are commonly recognized as significant results of successful risk management, further research is needed to understand how SCRM approaches enhance these capacities and boost operational performance. As traditional risks such as demand-supply imbalance, geopolitical uncertainty, environmental disruptions, and regulatory pressures continue to exit, the quick adoption of digital technologies has also given rise to new types of

vulnerability, such as cybersecurity, technological dependency, information-related risks, and system-integration challenges. Additionally, businesses must strike a balance between investments in risk mitigation, cost effectiveness, and service responsiveness. These findings point to the need for a more comprehensive knowledge of SCRM that links risk-management techniques with operational performance, resilience, and agility in supply chain settings that are becoming more unpredictable and technologically advanced.

4. CONCLUSION

Over the last two decades, SCM has emerged as a prominent domain of inquiry for academics and supply chain professionals to ensure continuous supply in a dynamic corporate environment. Supply networks serve as the cornerstone of the global economy, facilitating trade, consumption, and economic development. Globalization has increased competition in the supply chain, leading corporations to prioritize efficiency and cost-effectiveness, communicating effectively with suppliers and business partners is critical for many businesses (Mentzer et al., 2001; Wu et al., 2014). Optimizing SC operations and physical movement of commodities can result in cost savings. In an increasingly interconnected and turbulent global market, implementation of effective SCRM has become a crucial element for sustaining organizational resilience and competitive advantage. This assessment has underlined the multidimensional character of supply chain risks, which include anything from geopolitical tensions, cyber threats, natural disasters, and interruptions in demand and supply. Key themes that emerged include the significance of risk identification, assessment, mitigation, and continual monitoring. The integration of technology and collaborative partnerships throughout the supply chain has proven critical for increasing visibility, agility, and responsiveness to possible disruptions.

Despite advances in SCM procedures, numerous gaps remain, particularly in balancing cost-effectiveness with risk preparedness and tackling emerging threats such as climate change and digital transformation. Future research should concentrate on investigating the role of sustainability and ethical issues in risk management. To summarize, effective SCRM is no longer an option- but a strategic necessity. Organizations that invest in resilient, transparent, and adaptive supply chains will be better able to negotiate uncertainty and achieve long-term success in the face of developing global issues.

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