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Minimising Supply Chain Risks. Mitigation Strategies for Sustainable Private Organisations Development

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Abstract

This article provides an overview of academic papers that discuss strategies for minimising risks in supply chains. The sources cover a range of topics, including risk identification and management, classification of different types of risks, and practical guidance on risk assessment and mitigation strategies, thus providing to both supply chain leaders and researchers a detailed analysis of the various risks that impact supply chains, and the strategies that can be employed to minimise those risks.

The research methodology used to study and analyse the risks associated with supply chains and develop strategies to minimise those risks is simulation modeling, used to create a virtual model of a supply chain and simulate different scenarios to identify potential risks and test the effectiveness of different risk mitigation strategies, identifying potential challenges that could be implemented in real supply chains. The study focused on the risk of product shortages due to unexpected demand or supply disruptions, testing several parameters to measure the effectiveness of three risk mitigation strategies: Stockpiling - building up inventory to ensure enough product on hand to meet demand during a disruption; Diversification - creating alternative suppliers options minimise the impact of potential disruptions; and Collaborative planning - considering suppliers and customers to share information and coordinate production and delivery schedules.

The simulation results showed that each risk mitigation strategies were effective in reducing the risk of product shortages. However, the most effective strategy was a combination of all three strategies. The study also highlights how having information on a supplier's operations and inventory levels allowed supply chain leaders to make better reasoning and respond more quickly to disruptions. Overall, this study demonstrates how simulation modeling is showing through test results each parameter contribution to different risk mitigation strategies in supply chain management.

Keywords: supply chain, risk management, risk mitigation strategies, supply base management, collaborative planning.

JEL Classification: D81, F69, L52, N70, O19.

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1. Introduction

Supply chains involve the movement of goods and services from one party to another, often across different geographic locations. Participants in these supply chains have complex relationships established, especially in global or international supply chains where the parties are dealing with additional diversity and risk. The number of companies and processes involved in the supply chain can also increase its complexity. However, even in a two-party commercial relationship based on the offer-demand paradigm, there can be a wide range of risks that can impact the relationship, such as: Delivery risk- the risk that the delivery of goods or services will be delayed or fail to meet the required specifications; Overstock risk- the risk of carrying excess inventory or goods that cannot be sold, leading to a loss of revenue; Payment risk- the risk that one party will not receive payment for goods or services delivered; Insolvency risk- the risk of one party becoming insolvent or bankrupt, leading to a disruption in the supply chain; Single supplier or supplier dependency risk- the risk of relying too heavily on a single supplier or having limited options for suppliers; Quality risk- the risk that goods or services delivered will not meet the required quality standards; Warranty risk: the risk that goods delivered will not perform as expected and will require costly repairs or replacements; Liability risk- the risk of one party being held responsible for damages or losses resulting from the supply chain relationship.

International supply chains are aggravated by the multicultural factor of the participants involved. Each party may carry its own cultural mindset and values that can impact their actions during interactions. This can lead to misunderstandings, miscommunications, and even conflicts that can disrupt the supply chain, which is why these factors must be monitored and addressed when managing supply chain risks in global or international supply chains.

2. Problem Statement

Reading carefully the specialised literature dedicated to this thematic area allowed us to observe the multitude of studies that have focused on strategies to address supply chain risks, there is a lack of available information on risk management strategies used by decision-making managers in their day-to-day activities. We consider these strategies can be differentiated into rational and irrational selections. Rational selections are based on previous experiences and their consequences. For example, a manager who has dealt with a similar risk in the past may choose a similar strategy to mitigate the risk. Irrational selections, on the other hand, are based on strategic decisions made in unique situations that cannot be easily replicated as a model for future risk management decision-making. For example, a manager may choose to take a risk-minimising strategy based on the specific factors present in each situation, such as time constraint, financial constraint, or resource availability.

A definition of supply chain as viewed by Croucher et al. (2017) is represented by the sum of suppliers, logistics and customers, while the logistics can be defined

as materials management and distribution, below figure as built by the authors clearly represents interactions and complex flows found typically in supply chains, that bear both opportunities and risk on each component.

Figure 1. Logistics components and flows – fast moving consumer goods
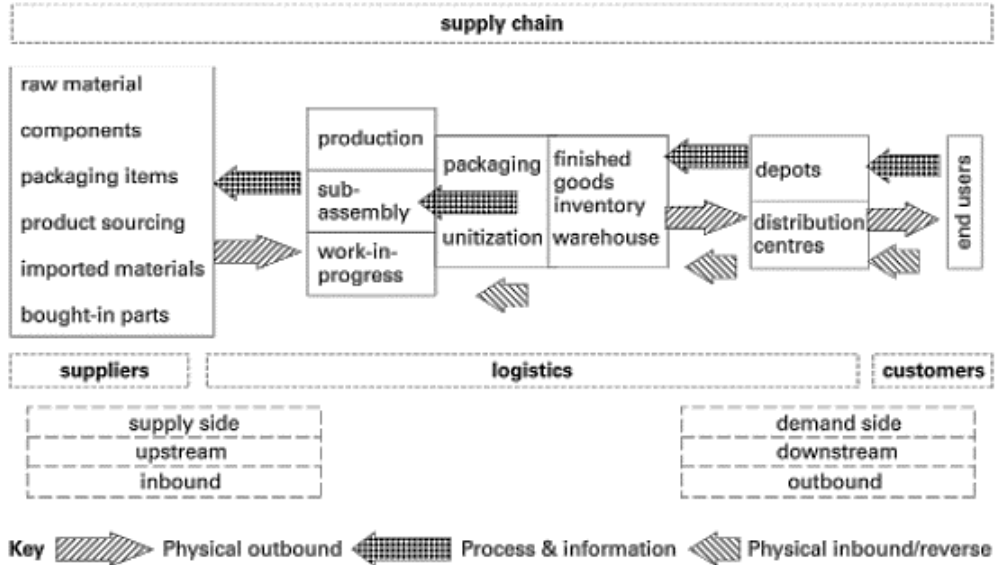
Source: Croucher, P., Baker, P., Rushton, A. (2017). The Handbook of Logistics and Distribution Management: Understanding the Supply Chain, p. 5.

Ghoshal (1987) classified risks into the following categories: macroeconomic, policy, competitive, and resource-related risks. Furthermore, he details from the above-mentioned categories the events that bring the most relevance to Supply Chain Risk Management (SCRM), such as: foreign exchange rate, energy rate, lead time for transportation, provisioning demand, inventory management, quality catalogue, potential hardship leading to stop of economic activities, supplier dependency, safety, survival, or cultural associated risks. These risk events are interconnected and can lead to complex patterns of risks in global supply chains; for example, managers compare domestic versus China sourcing to illustrate how each of the specific risks are linked to each other: cycle time to produce a part, the transit time spent on sea, and the issues encountered with forecasting. Forecast errors in supply chain management are exacerbated by longer lead times and can contribute to companies overreacting by stockpiling inventory to avoid shortages, which can lead to excessive inventory and production shutdowns. This cycle of overreaction can cause a pendulum swing between shortages and excessive inventory, also known as the bullwhip effect. The comparison is made to forecasting the weather, where shorter-term forecasts are more accurate than longer-term ones.

Ila Manuj and John T. Mentzer (2008) describe global supply chains as a tool of competitive advantage that companies have by providing access to a wide range

of resources and markets. These resources include labour, raw materials, financing, and government incentives, among others, that can be tailored to meet the specific needs of each participant. However, this international collaboration comes with various risks and uncertainties that may arise before, during, or even after the collaboration is finalised.

Strategies proposed by Tang in 2006 aim to manage fluctuations efficiently and make supply chains more resilient, but these strategies have not been assessed for their effectiveness. Demand risk mitigation involves various methodologies such as automatic pipeline inventory, order-based production control systems, two-period financial models, buyer's risk adjustment models, and simulation models. Mathematical programming models, such as stochastic integer linear programming models, mixed-integer stochastic programming models, stochastic linear programming models, and mixed integer nonlinear programming models are also used to reduce the consequences of demand uncertainty on supply chains.

Brusset and Teller (2017) identify in scheme below the input to output of resources allocated within supply chains, that enable the ability of a supply chain to revert to previous condition after overcoming a disruption, either natural or operational.

Figure 2. Resource based view of supply chain
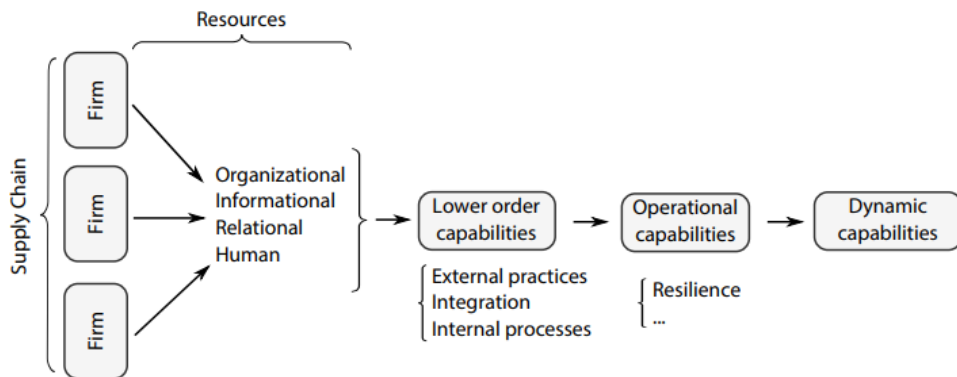
Source: Brusset, X., Teller, C. (2017). Supply chain capability, risks and resilience in: International Journal of Production Economics, p. 3.

Studies tried to link risk mitigation strategies in SCRM and the application of Artificial Intelligence (AI) techniques. SCRM is targeting to identify, measure and reduce risk, while monitoring unexpected events or conditions that can have an impact at any level of the supply chain. AI techniques, such as mathematical programming, machine learning, and big data analytics, are suitable for SCRM because of their ability to process large, multidimensional data sources and enable rapid and adaptive decision-making. There are various definitions and classifications of supply chain risk which can be addressed using AI methodology having the specific task to manage supply chain risk. The analysis identifies areas for future research at the intersection of SCRM and AI.

Also, the focus of many studies in SCRM has been on supply risk mitigation. Empirical studies have shown that strategies such as behaviour-based management techniques, creating a network of strategic suppliers, customer being involved in supplier development, awarding strategic business volumes to ensure capacity utilisation and business continuity, reducing within these partnerships the supply base complexity can help mitigate supply risk.

The supply chain structure must be fully known for SCRM to be effective. Ho et al. (2015) provide a risk definition that refers to the likelihood and impact of events that are unexpected, or adverse conditions which have an influence within any level of the supply chain, having as consequence failures at strategic or operational level.

Ho et al. (2015) identified five separate groups of supply chain risks. The first group is formed by generally applicable risks to the complete supply chain instead of a certain level or activity related to it; they are also known as scope, macro, or environmental supply chain risks. The second group of risks is concerning the level of supply in supply chain and can also be referred to as source risks, being focused on any unforeseen event and outcome incurred in this level of the supply chain. The third group of risks is related to demand issues, including forecasting issues and delivery risks, which add up to build the bullwhip effect or demand distortion and associated actions flowing from it. The fourth group of risks is named make risks or manufacturing risks and is related to supply chain processes, while the fifth group of risks is comprised of infrastructural risks and is having in view the control over supply chain activities.

Part of the studies reviewed focus mainly on creating and ranking mathematical models that analyse uncertainties and risks, while the focus is less on explaining and proving the applicability of the models in practical situations. Baryannisa et al. (2018) find in their study that approximatively 53% of the papers considered do not enable readers to gain additional capability for decision-making, 39% share feedback from managers, and remaining 8% can structure a decision-making support mechanism, especially in the categories of agent-based, reasoning, Machine Learning, and Big Data. Therefore, the studies consulted cannot be referred to as a basis information support to help improve decision making for practitioners in the search for solutions to address different supply chain risks.

The concept of risk in the context of supply chain management refers to the potential for losses or negative consequences that can occur if a risk event actually takes place. This includes considering the likelihood of such events occurring and the possible impact of these losses or negative consequences. In this context, risk events are considered uncertain events that can lead to the realisation of risk. The probability of occurrence of a risk event and its potential impact are commonly referred to as dimensions of risk. These dimensions are of particular importance in the context of global supply chains, where the speed and frequency of risks can greatly impact supply chain performance.

In addition to the dimensions of risk, the speed of risk is also an important factor to consider. Slow discovery of a risk event can exacerbate the consequences and increase additional risks.

Manuj, I. (2008) determines the impact and measures the speed of risk considering the following parameters: rate of occurring risk event that has as consequence quantifiable loss, rate of periodicity for the occurring risk event, rate of achieved losses materialised measuring how often the loss is applicable and the rate of risk prediction showing how fast the risk is visible in the organisation to enable decision makers to undertake strategies for its mitigation.

Risk is difficult to measure even when its effects are produced, as shown by K. Snyder (2014). Moreover, it becomes even more challenging to forecast the impact of a potential risk event, reason why companies which engage in risk mitigation strategies will need to invest in supply chain resilience proportional to the impact they foresee applicable to a particular risk they attempt to mitigate. For example delivery stop from a supplier can be measured as the cost of penalties paid to the customer in the given contractual conditions and mitigated with alternative source qualification. The cost assessment for this alternative supplier mitigation strategy needs to be justified as being more competitive than the event of risk materialisation.

Physical distance and production time, and transport duration differences can also contribute to the extent of high or low impact risks faced by global supply chains.

Risks encountered in supply chains can be differentiated also based on the source of risk initiation: supply risks covering all supplier and supply related incidents that may have unknown impact, demand risks covering volatility of demand and potential unbalances that could arise at each level of the supply chain, operational risks arise in connection with unwanted events that disable the company to produce goods or services for the market, and security risks associated to potential issues with health, safety, integrity of customers and information.

These risks can arise from a variety of sources within the supply chain, such as supplier performance issues, changes in customer demand, disruptions in production processes, and security threats.

In comparison to other types of risk mitigation, Zhang et al. (2011) identified the risk monitoring as potential strategy that would allow companies to foresee certain risks, understand their occurrence, and mitigate the risk impact by implementing adapted solutions as response to a particular unknown situation, in alignment with the company's processes and values. Risk monitoring was therefore studied using diagnosis model to raise pre-notifications for certain events, showing that this system can identify abnormal data and decide the issuance of a warning; however, the study used only quality data and was not verified using real data.

S.Y. Ponomarov and M.C. Holcomb (2009) show the correlation between logistic capabilities and supply chain resilience through organisational learning: an adverse incident or unexpected event can help to prepare for future similar events or disruptions, thus strengthening the supply chain by creating new logistics strategies, developing tactics, and operations to support further logistics capabilities.

In summary, although risk, uncertainty, vulnerability, and sources of risk are often used interchangeably in supply chain risk management, they each have distinct meanings. Furthermore, there is a need for more information on the risk

management strategies used by decision-making managers in their day-to-day activities, including differentiating between rational and irrational selections of risk management strategies.

While companies that take on high risks may be rewarded with high profits, it is important to note that even the most competitive supplier with the lowest price may bear the highest risk if their supply chain does not consider, quantify, and mitigate potential issues that may arise at each level of its supply chain. This can include risks associated with raw material suppliers, transportation, manufacturing processes, warehousing, distribution, and the final delivery to consumers. Therefore, companies need to carefully consider these risks and take appropriate measures to mitigate them to maintain their competitive advantage and ensure long-term success.

While risk management has been an important topic for multinational companies for many years, there is a multitude of studies addressing the risks associated with supply chains over the past two decades. This is due in part to the increasing complexity of supply chains and the need to manage risks across multiple levels and geographic locations. As a result, there has been a growing body of research focused on identifying, assessing, and mitigating risks in supply chains, with the aim of developing effective risk management strategies that can help companies maintain their competitive advantage and ensure long-term success.

Risk, uncertainty, vulnerability, and sources of risk are often used interchangeably when discussing SCRM. However, they each have distinct meanings. Risk refers to the potential for adverse outcomes to materialise. Uncertainty refers to the reality that the full extent of possible outcomes is not known. Vulnerability, on the other hand, refers to the susceptibility to harm or damage in the face of risk and uncertainty. Sources of risk are the specific events or conditions that can lead to adverse outcomes in a supply chain.

M. Wang et al. (2019) focus on logistics innovation capability, showing that a company's ability to incorporate logistics innovation can enable problem solving and improve resilience to the changing environment, while achieving logistics operational excellence and reducing the impact of supply chain risks through proactive risk management activities.

Considering status and approach of the studies reviewed, we can state that risk management is a thematic area that has vast amount of applicability within supply chains, as they are constantly exposed to multiple categories of risk. Checking both the theoretical approach and the pragmatic approach, supply chain experts can rely on the existing literature to understand and assess their situation, however, not having enough models in hand to enable them to develop a decision-making scheme which would ease their procurement process and therefore through simplification reduce the risk exposure in a given situation.

3. Research Questions / Aims of the Research

A first hypothesis from which this study started is that supply chains are facing greater risks correlated with their complexity and global footprint- while providing competitive advantages, a multicultural supply base with international logistic chain

may incur high associated risks that require diligent management approach and mitigation. *A second hypothesis* tested during the research carried out considered the fact that effective risk mitigation is the result of high-level purchasing strategies applied by supply chain professionals, in both rational and irrational selections. *A third hypothesis* tested started from the assumption that applying risk mitigation strategies is effective in reducing the supply chain associated risks; however, a unique mix of risk management strategies is needed to be implemented for each company specific activities, and even in the same company there are increased complexity topics which cannot be sorted with a strategy model and need new strategic approach to incorporate all potential risks, opportunities solutions for that particular case, thus making supply chain managers key decision makers in this international supply chain risk management process. Secondary hypothesis considered supply chain professionals identify and connect the risk with the implemented strategy; however, this did not guarantee the success of the strategy selected, due to misalignments with performance key performance indicators, flexibility within the supply chain, and the supply chain team membership. Nonetheless, the study suggests that supply chains that adopt strategies aligned with the risks they face should perform better than those that do not. The concept of harmonised strategy and environment is complementary to the fit in concept detailed in strategy literature, that explains how one resource's ability to mitigate loss or increase profits is correlated to the fit of the strategy and the external environment, being aligned with the idea of matching the supply chain type with the demand variations incurred in a particular supply chain.

Therefore, the aim of the research is to demonstrate that there is no unique mechanism any company could apply to ensure a minimum risk exposure in a certain date in time. Each industry, company and tier to tier relationship is to be managed separately together with its specificities. While some are relying on previous experiences decisions, others on pure cultural factors and others on critical inputs of a scenario, the interconnectivity of the supply chain will need in depth collaboration to ensure a risk is mitigated, a loss is overcome, and lessons learned implemented. In such a tight correlativity relationship between customer supplier in depth 3-4 layers there are no single failures or single winners but interconnected financial and performance results, reason why strongest partners in supply chain can become strongest market leaders.

4. Research Methods

This paper is presenting positivist research methodology combined with simulation modelling methodology, used to create a virtual model of a supply chain, and simulate different scenarios to identify potential risks and test the effectiveness of different risk mitigation strategies identifying potential challenges that could be implemented in real supply chains. The study focused on the risk of product shortages due to unexpected demand or supply disruptions, testing several parameters to measure the effectiveness of three risk mitigation strategies: Stockpiling - building up inventory to ensure that there was enough product on

hand to meet demand during a disruption; Diversification - creating alternative suppliers options to reduce the impact of supply disruptions; and Collaborative planning - considering suppliers and customers to share information and coordinate production and delivery schedules. Also, the article is focused on a combination of positivist-type research, prioritising the main risks associated to supply chain, and phenomenological-type research, during which the most robust of the correlations supporting the starting hypothesis were highlighted. Therefore, we believe that increasing attention to minimising supply chain risks within the organisations will lead to improved performance of the company and strengthen its supply chain.

Manufacturing companies were chosen as a representative example of global supply chains because they are often the most visible and easily identifiable aspect of a supply chain. They are responsible for producing the final product that is sold to the end customer. Therefore, manufacturing companies are often the main focus of supply chain risk management efforts.

It is important to note that there are several other levels of the supply chain that are not related to the manufacture of the final product, such as logistics providers, quality control providers, assurance providers, and engineering providers. These levels of the supply chain also play important roles in managing supply chain risks. However, for the purposes of this study, the focus is on manufacturing companies, as they are a representative example of global supply chains and often the primary focus of risk management efforts.

5. Findings

We identified four types of supply chain risks and their interaction in the global environment, while making descriptive analysis of the risks management strategies and the prior steps and reasonings for selecting a particular strategy to follow. Few of the parameters explored and evaluated to have a high influence are the composition of the team, the management of a certain degree of complexity found in the supply chain, and the ability to undertake and apply learning in the inter-organisational structure. To develop the risk management model presented in this study, the researchers also reviewed and summarised findings from similar studies. This helped to provide additional insights and context for the development of the model.

Supply chain disruption risk can occur as consequence of several factors such as political setup, natural hazards, economic instability, or supplier financial issues. This disruption can lead to both financial loss and reputational damage for the company and is materialised when an incident associated with inbound supply is stopping the supply chain advancement of regular activities, having as outcome the inability of the purchasing firm to follow its commercial commitments, to meet the customer demand, or causes threats to customer life and safety. Operational risk is referring to any risk regarding product flow, information and material incurred within the supply chain from the raw material supplier to the final customer of the finished good, which encompasses the risks associated with the day-to-day

operations of the supply chain. It includes risks such as production disruptions, quality issues, inventory management, transportation delays, etc. Performance risk is referring to a company not achieving its key performance indicators that are of high importance in its day-to-day activities, thus impacting both its customers and suppliers. An example of the risk of not achieving the desired level of performance or meeting performance goals is not achieving the targeted turnover to allow a certain percentage reinvestment in new product launches and research and development initiatives. It can arise due to various factors such as operational inefficiencies, supply chain disruptions, and market changes. Process risk refers to inconsistency in the outcomes available at each supply chain level participants, that will influence the variation of value added created per level and is the risk associated with the various processes involved in the supply chain. It includes risks such as production process failures, quality control issues, and delays in delivery. Supplier risk is referring to an action coming from the supply side of the supply chain that causes disruption of activities and products as an effect of a risk situation scenario, being the risk associated with the performance and stability of the suppliers in the supply chain. It includes risks such as supplier bankruptcy, supplier quality issues, and supplier delivery delays, which are captured and monitored at each company level with certain key indicators summarised in a centralised, quarterly or yearly refreshed supplier score rating file.

Figure 3. Product shortage mitigation strategies
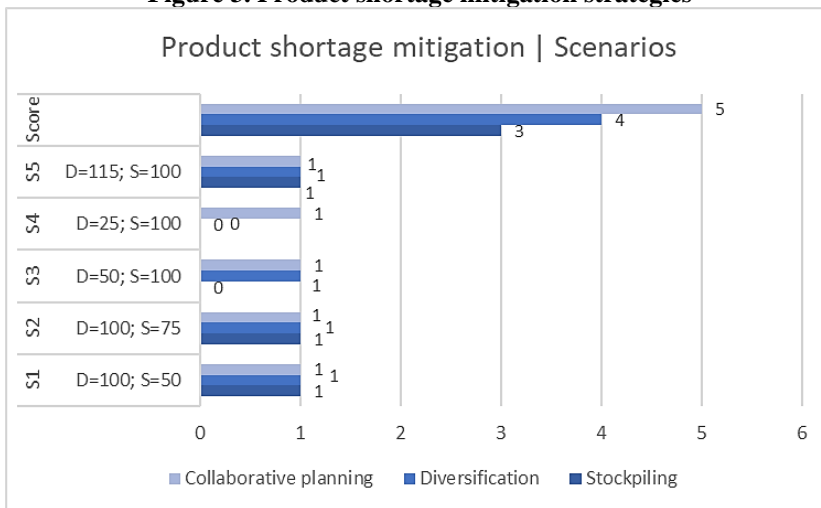
Source: Created by author.

	S1	S2	S3	S4	S5	Score
Parameters	D=100; S=50	D=100; S=75	D=50; S=100	D=25; S=100	D=115; S=100	
Stockpiling	1	1	0	0	1	3
Diversification	1	1	1	0	1	4
Collaborative planning	1	1	1	1	1	5

Source: Created by author.

Risk assesed: product shortage due to demand/ supply disruption

S1,..S5	Scenario 1, ..5
D	Demand
S	Supply
0	invalid respose| delivery supply failiure
1	valid response	risk mitigated

Source: Created by author.

There is a significant importance of selecting a research strategy that is appropriate for the research problem at hand. In this study, the research problem was related to understanding the phenomenon of risk management in global supply chains, with a specific focus on manufacturing companies. The Bills of Material reveal the aggregate cost of transferring a component from its source to the receiving area, known as landed costs. It is strategic to seek suppliers near the customer's location or with lower import charges. A balance must be found between the lower prices from far-off suppliers and the added transportation costs, including considerations about the potential risks associated with longer transit times. The design of a product has a direct bearing on the material cost. The product's attributes can stipulate the use of specific materials or precision requirements, influencing the choice between manufacturing in-house or outsourcing. Higher purchase volumes typically result in price reductions as suppliers can quickly recoup their equipment and startup costs. These volumes could also justify the use of more automated equipment and help reduce changeover times.

The company's decision to manufacture in-house or source from suppliers directly affects the skillset requirements and potential capital investment in the facility. Companies should carefully assess the benefits and drawbacks of dual sourcing, which can foster competition, improve quality, and potentially lower prices, but also introduce complexities in logistics and supply chain risk.

One of the findings of diversification parameter in depth analysis is the hedging strategy used to mitigate the supply side risk in global supply chains. Hedging means creating a footprint of global suppliers and facility locations for the same supplier to prevent a single event from affecting all entities at the same time and magnitude. Although it is associated with higher investment, hedging can help manage risks such as quality, quantity, disruption, price, variability in performance, and opportunism. Dual sourcing is an example of hedging, but it involves more capital expenditure than the single-sourcing strategy. Quality and process controls are crucial for hedging to be effective. Overall, hedging requires significant investment and is only valuable for cases where the risk is higher than the expense and the expense can be covered with the project financials or in cases of high-risk supply chains.

SCRM strategies are used in the global supply chain with the intent to minimise loss, speed, exposure, probability, and frequency of risk events and to better cope with their outcomes reflected on each level of the supply chain. Choosing the right risk management strategy fit to the purpose should enable improved performance of

the supply chain; however, in practice the complexity of the supply chain and the increased inter-organisational exchanges of lessons learned can contribute to moderate the correlation between risk management strategies selection and risk outcomes of a certain risk management event.

Each supply chain has its own complexity associated based on the type, structure, and amount of inter-connected actions, processes, and transactions happening within it, which has also a correlated impact with the risk levels associated to running operations, therefore, if the complexity factor could be adjusted and diminished we would potentially observe correlated risk reduction, reason why reducing supply chain complexity is one of the strongest correlations of risk mitigation strategies and is a strategic operations goal for companies looking to minimise and mitigate supply chain associated risk.

Global supply chain managers should consider the degree of complexity in their supply chains and aim to reduce it as much as possible. Additionally, they should focus on adopting inter-organisational learning processes to help mitigate the effects of complexity.

We identified various strategies for mitigating risks in different areas of the supply chain, as each level and action could potentially undertake risks, such as: transportation risks, avoiding last minute transport arrivals that may impact production planning or customer deliveries, financial risk mitigation by ensuring both the operating company and its business partners are in good financial health that would allow them to perform daily operations, ensure cash flow levels in line with performance targets and bankruptcy risk mitigated, information risk mitigation by putting in place processes and procedures to avoid information loss, misused or stolen through phishing campaigns. Also, the literature reviewed showed that supply chain risks can be addressed and mitigated also by putting in place behaviour-based management techniques, such as building strategic supplier relationships, adopting business continuity planning, reducing supply base complexity, and increasing flexibility. Other strategies include building collaborative relationships, sharing information, strategic supplier management, increasing capabilities, having corporate social responsibility programs in place to motivate and empower both employees and business partners together with showing an in-depth understanding of diverse and complex organisational cultures. However, there are limitations to these studies, and more research is needed to develop effective risk mitigation strategies.

6. Conclusions

Supply chain definition did not reach consensus, having in view the literature reviewed, each study undertook its own key factors parameters to have a quantifiable importance in supply chain understanding and breakdown. In the early stages of supply chain risk management development, it some registry terms were translated from fields such as finance and risk management specific to companies, while in time it developed its own complex registry populated with categories specific such as: supply base management, risk diversification, budget sourcing, contingency

plans, gap analysis, risk assessment. Even if risk is defined differently depending on the field where used, there is a general acceptance of the idea that risk is equivalent with the exposure to uncertain event which will occur with unknown probability and having a quantifiable outcome.

Authors approach risk as both subjective and objective phenomenon, involving both possible positive but most likely negative outputs. This has been studied in detail in the SCRM literature, while some studies argue that risk is defined by the stakeholders' positioning while other studies sustain the objective dimension based on risks that are commonly measured and ranked. While risk is risk is typically associated with severe negative consequences, some researchers also highlight some positive effects that may be experimented with in a situation bearing a high degree of risk. Risk is also linked to uncertainty, with some viewing it as the expected outcome from an uncertain event, while others see it as the uncertainty of possible outcomes. Some researchers have created models to enable decision-makers to assess their supply chains, based on different levels of uncertainty in the rage of complete certainty and radical uncertainty. In typical SCRM, participants are aware of the structure in which they act and about the probability that a future event will affect their objectives, based on experience and the status of market evolution. A late order placed in for Europe to a supplier located in India may incur delays based on known transit times, customs delays, quality issues coming from long term storage and other risks, while a period with expensive credit will have an impact on supplier own investment in a given project. In more uncertain situations, subjective beliefs are relied upon for SCRM. While further research is needed to fully understand the impact of these factors on performance outcomes, managers can start by implementing the risk management strategies approached by this study. The literature review demonstrates the increasing interest in SCRM, and the diverse approaches taken by researchers to identify and classify potential risks and risk factors in the supply chain. The reviews also highlight the gaps and challenges in the field, such as the missing unitary approach on SCRM definition and the need for more empirical methods to address risk incidents. As such, there is still much work to be done to fully understand and effectively manage supply chain risks.

In terms of logical events, SCRM can occur both in a proactive and reactive strategy. While most companies have in place risk management department to manage and mitigate risks, the reactive strategies tend to be more utilised as they are implemented after a risk materialises, ensuring the right resource allocation. The proactive strategies are meant to assess and foresee risks prior to their occurrence, allowing for suitable mitigation and contingency plans to be prepared. Research has placed more focus on proactive strategies due to the significant damage that delayed risk responses can cause, in contradiction with practice that is seeing a vast array of risks to manage and rarely finds the time for proactive planning and risk mitigation, reason why we find this subject is of high impact and importance as it can bring an additional insight and reference for supply chain leaders and experts active in supply chain risk mitigation.

Considering 2020-2023 events affecting drastically international supply chains, such as coronavirus and the war in Ukraine it is clear that risks needed to be foreseen, ranked, mitigated and each company needs to have in place a set of contingency actions in front of an uncertain event which can determine significant losses, putting an emphasis on proactive strategies that require accurate predictions and determinations of the probability of a risk occurrence and the easy calculation of its impact together with accepted mitigation strategy associated, to enable quick recovery in the event of risk materialisation.

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