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Introduction

Due to its worldwide scope and systemic influence on the firm's financial performance, the supply chain is perhaps more vulnerable than other sectors of the business. Due to the numerous dynamics that drive supply chain risk, risk is a reality of life for supply chain professionals. Quality and safety issues; supply constraints; legal, security, regulatory, and environmental compliance; weather and natural calamities; and terrorism are just a few of them. Companies with global supply chains are exposed to additional risks, such as the longer lead times required in a global environment; supply disruptions caused by global customs, foreign regulations, and port congestion; political and/or economic instability in a source country; and changes in economics such as exchange rates.

The supply chain's size and reach necessitate a proper, documented risk management strategy. Risk planning, on the other hand, typically goes to the bottom of the priority list when there isn't a crisis to spur action. It's perplexing that risk management is given such a low priority in businesses. After all, supply chain risk management is a hot topic at conferences and has spawned a slew of books and articles on the subject. Despite all of the fanfare and debate, the great majority of firms are still paying this problem far less attention than it deserves.

There is, however, a silver lining. Risk cannot be completely eliminated, but it may be anticipated. Because relatively few businesses have one, having a risk management plan may be a competitive advantage. Preventing supply chain disruptions has a significant influence on

overall competitiveness. Supply chain interruptions have far-reaching consequences that can damage a company's financial health. Missed customer promises, stock outs, lower profitability,

greater inventory levels, longer time-to-market cycles, lower product quality, and unfavorable brand impression may all be avoided with an efficient supply chain risk management approach.

This article looks at Colgate Palmolive. The consumer goods corporation established in New York is a global leader. Its brands, which include some of the most well-known household names in the world, are distributed in more than 200 countries and territories. Colgate toothpaste is present in more than 62 percent of homes throughout the world, more than any other brand.

Consumers trust and rely on its Speed Stick, Lady Speed Stick, Palmolive, Ajax, Softsoap, and Hill's Pet Nutrition brands.



2.0 Supply Chain Risk

Since incidents like 9/11 and Hurricane Katrina, the corpus of research on hazards and supply chain risks has grown. Globalisation and certain management initiatives, such as increased outsourcing, reliance on single suppliers, supply chain complexity and interdependency, increased competition and more demanding and higher-expecting customers, a trend toward increased regulation, and more unpredictable threats, all increase the susceptibility of supply chains to risk. Risk isn't always bad if it gives you a competitive edge, but businesses should know how much risk they can take.

2.1 Risk

Supply chains are exposed to more hazards than ever before, which are numerous and ever-changing, and come from both within and outside the firm. They're also getting more expensive. Today's management has a difficulty in avoiding such risks or limiting their negative consequences. Some risks, however, cannot be avoided, and in today's complex global supply chains, piecemeal solutions and individual projects are no longer sufficient to address the varied nature of threats.

Risk is defined in a variety of ways in the literature. (Christopher & Peck, 2004) define risk as "in accordance with ordinary use in the sense that it pertains to supply chain vulnerability, as at risk: vulnerable; likely to be lost or destroyed," and proposes a three-class classification: i) Within the organization, ii) Outside the organization but within the supply chain, and iii) Outside the supply chain.

Table 1 shows some definitions of risk

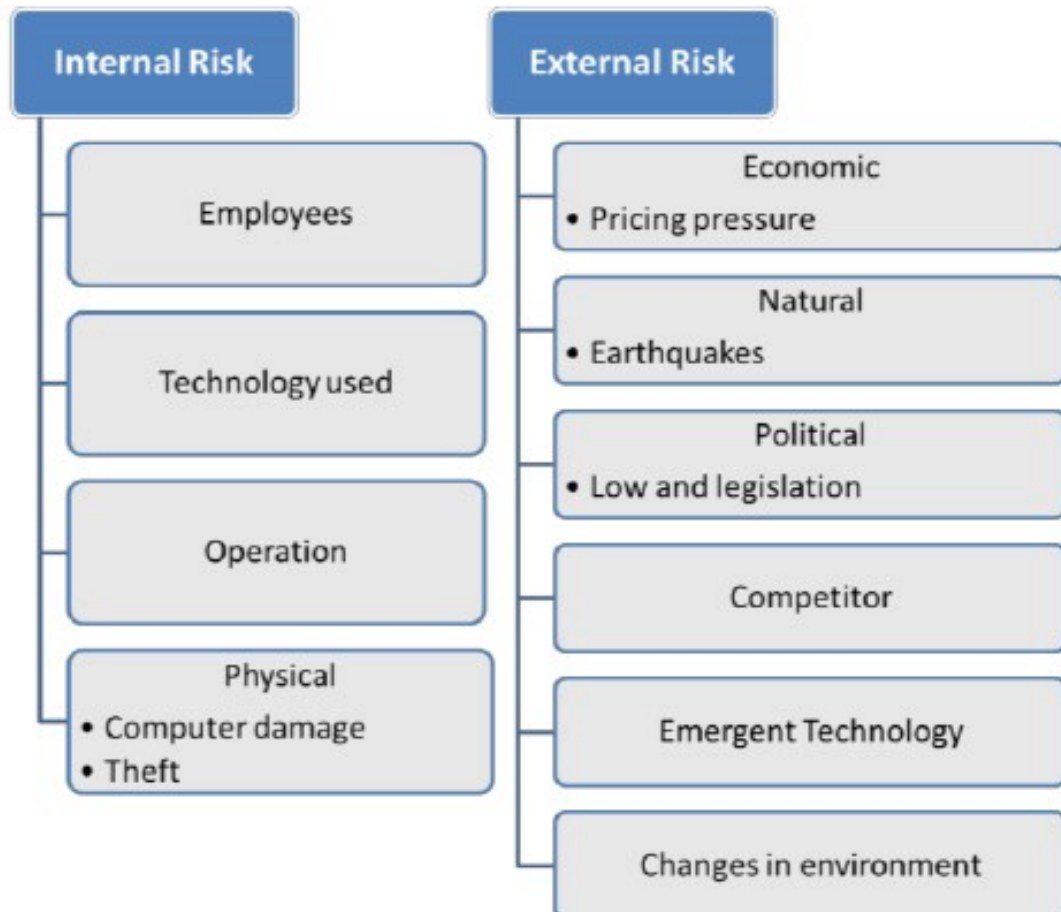
	Risk definition
(Peck, 2004 p 7)	Risk is used in the sense that it refers to the fragility of the supply chain, as in at risk: vulnerable; likely to be lost or destroyed.
(Wagner & Bode, 2008 p 307)	Negative divergence from the expected value of a performance metric, resulting in unfavorable implications for the local organization, is referred to as risk.
(Manuj & Mentzer, 2008 p 192)	Risk is the predicted outcome of an unknown occurrence, i.e. hazards arise as a result of uncertain events.

2.2 Risk Sources

The sources of risk, it is widely agreed, become increasingly relevant as the complexity of contemporary supply chains grows. Depending on the risk source, more appropriate activities for reducing the negative effects of risks must be taken. Knowing the source of the risk may enable

you to take steps to minimize or mitigate the risk's occurrence and, as a result, its negative impact on business outcomes. There are several sources of risk that have the potential to negatively impact revenue and cost, lowering supply chain performance and competitiveness. The key aspects of possible sources of risk in the supply chain are clarified through classification.

Based on a review of the literature, two types of supply chain risk are identified: external and internal to the supply chain. Each of them is subdivided by one or more writers. The sources of risk that are external to the supply chain are those that arise from the environment in which the supply chain operates. It encompasses, on the one hand, factors that influence demand at the end customer level and, on the other hand, events that, when they occur, have a significant impact on the region in which they occur. Natural disasters such as tsunamis, earthquakes, hurricanes, and floods (Bode & Wagner, 2008 p 307); human-made catastrophes such as computer viruses, destructive competitive acts, sabotage, and terrorist attacks (Sheyii, 2010 p 11); and iii) the implementation of laws and policies affecting the supply chain, such as trade and transportation laws, as well as the degree and frequency of changes in these laws and policies This category, on the other hand, refers to situations that are beyond the control of supply chain management.



3.0 Supply Chain Risk Management

Supply chain risk management aims to identify potential sources of supply chain risk and implement appropriate actions or strategies through a coordinated approach among supply chain members to avoid or reduce supply chain vulnerability (Peck et al. 2003 p 197), as the goal of risk management is ultimately to mitigate negative influences and ensure the company's success (Diehl & Spinler 2013, p 311).

3.1 Risk Management Process

The supply chain risk management process comprises the systematic application of management policies, methods, and practices in carrying out a series of tasks such as risk identification,

analysis, evaluation, treatment, monitoring, and communication. Risk Identification, Risk Assessment, Risk Response, and Monitoring and Review are the four primary actions in this iterative process. This method may be used to provide the supply chain qualities that make it more risk-resistant.

Identifying areas of susceptibility is the first step in reducing supply chain risk. Companies may focus their efforts on the regions that are most at risk by using good mapping. These are the areas where supply chain resilience can be improved the most. Companies should analyze risk over a lengthy period of time while mapping supply networks in order to leverage long-term possibilities to increase resilience. Colgate-Palmolive, for example, collaborated with MIT academics to expand their risk-mitigation horizon from five to twenty years. Many of their goods rely on mint derivatives, which are dependent on the quality and quantity of mint crops. While short-term events like as fires can have a big influence on sourcing, long-term effects such as shifting weather patterns, increasing flooding, and droughts can have even greater total consequences. Colgate-Palmolive can better understand their risk by expanding their risk horizon, allowing them to cooperate with their supply chains to improve their climate resilience.



The Risk Assessment activity follows the Risk Identification activity and is crucial in the supply chain risk management process. The analysis and appraisal of risk are carried out in this activity. Furthermore, the degree of exposure to identified hazards is determined, represented as likelihood and effect, and the risks are graded. Management should decide how to respond after identifying and assessing the relevant risks (next activity in the process). Companies can discover numerous approaches to mitigate these risks after the sensitive regions have been identified. On a case-by-case basis, the optimum course of action will differ. The re-evaluation of supply chains as a result of Covid-19 should also adhere to the same risk-minimization criteria. When changing supply networks, keep in mind the global trend toward deglobalisation, since trade restrictions such as tariffs may impact the cost of international supply chains in the future.

Adding variety to supply chains by acquiring materials and goods from a larger range of areas and firms is the most obvious strategy to reduce risk. Increasing diversification decreases reliance on a small number of sources, reducing the effect of any supplier service outages. Diversity is a hot topic in the supply chain right now, and for good reason. Organizations with strong established connections with suppliers, on the other hand, may want to collaborate with their supply chains to better understand their risks. Collaboration with suppliers not only minimizes supply chain risk, but also lowers prices, reduces manufacturing error, and allows for collaboration on other issues like security and logistics.

Both tactics are quite diverse and have distinct advantages, making them ideally suited to various organizations. Companies must develop measures to analyze their impacts regardless of whatever methodology they use. A company's understanding of results and implications over time might be aided by quality metrics. This enables businesses to determine whether their

strategy is working and, if not, to adjust their activities accordingly. Risk scenarios should be examined on a regular basis, as should any modifications to the supply chain, because planning is the key to avoiding supply chain interruption.

The goal of supply chain risk management, according to (Pujawan et al. 2009 p 953), is to build resilience and lower the possibility of risk events happening, which differs from (Juttner 2005, p 120)). As a result, the Supply Chain Risk Management Process's Responding to Risk activity should identify and analyze the activities that minimize the negative consequences of risk, i.e. those that allow risk mitigation, as well as choose and implement the most suitable in terms of supply chain resilience. For organizations to succeed in the future, they must manage supply chain risk. Businesses may reap the benefits of global supply networks without putting themselves at the whim of external pressures by diversifying supply channels or simply cementing strong supplier relationships and excellent practice. Covid-19 has shown what may happen to future global commerce if these dangers are not taken into consideration. Now is the time for businesses to act to secure themselves and their supply networks in the future.

3.2 Risk Response Strategies

Risk avoidance, acceptance, transference, and mitigation are all examples of risk reactions. If the risk has been determined to be undesirable or intolerable, risk avoidance is the best alternative. Risk response may be accomplished through risk reduction, which is implementing particular techniques to decrease or even eliminate risk chance, risk effect, or both. There is a lot of research (Kull, 2008 p 117) that proposes techniques for dealing with corporate and supply chain risks. There are several methods for reducing the negative consequences of supply chain risks on

performance results. A primary approach would be to aim to keep supply chain performance metrics such as order fulfillment consistency, delivery dependability, and customer happiness at a high level.

To respond to risk, supply chain organizations might use either a proactive or reactive strategy.

A proactive approach alters its procedures prior to the emergence of a danger. Supply chain organizations that use this approach are frequently attempting to avert a future hazard or capitalize on a future opportunity. A supply chain entity reacts to a risk and performs a reactive change when it modifies its procedures after the risk has already happened. Contingency and mitigation techniques are described in reference (Tomlin, 2006 p 357) as two broad approaches to coping with hazards. In summary, contingency plans are more reactive, whereas mitigation techniques are more proactive (Tuncel & Alpan, 2010 p 250). Mitigation techniques include taking steps before a risk happens in order to lessen the likelihood of the event occurring or its impact. As a result, whether or not an unforeseen event or consequence happens, the firm or supply chain bears the cost of the mitigation measure (Saad, 2005 p 53). Contingency tactics, on the other hand, are activities implemented only after a disruptive event has occurred. Reference (Tomlin 2006, p 639) further points out that risk management can be accomplished through a combination of strategies.

Multiple possible sources of risk have different consequences on a supply chain, making it more difficult to choose a risk mitigation method. (Chopra & Sodhi 2004, p 61) discuss eight risk mitigation measures that may be classed as either redundancy or flexibility strategies and are used in practice. Increased capacity, increased inventory, and redundant suppliers are examples of redundancy techniques. Flexibility tactics include increasing responsiveness, increasing flexibility, and aggregating demand, increasing capacity, and having more clients.(Chopra &

Sodhi, 2004) created a matrix that illustrates how each method works to mitigate the seven different categories of hazards (these risks do not include systems risk and intellectual property risks). An examination of the matrix suggested by these authors demonstrates that implementing some techniques reduces the chance of some categories of risk while increasing the likelihood of others.

Reference (Taleb et al. 2009 p 81) proposes redundancy as an effective risk management approach since the lack of redundancy renders organizations sensitive to changes in the business environment. However, certain redundancy-based techniques can be quite costly, and supply chains should re-examine the efficiency-redundancy trade-offs (Christopher & Peck, 2004 p 14). Companies should assess their risk profiles and consider storing strategic inventory reserves to guard against catastrophic catastrophes, according to (Sheffi, 2001 p 7). (Tang 2006, p 33) examines supply chain risk management and divides supply chain robustness techniques into two categories: those that improve supply chain efficiency and those that improve supply chain resilience. Business continuity planning within single sites tends to focus on strategies that strengthen a facility's operational capabilities to handle a risk by making the supply chain more efficient. However, resilience focuses on a company's capacity to continue operating and recover rapidly in the face of a danger. Reference (Gastaldi 2006, p 700) advocated similar techniques and added increase of capacity to Tang's list, whereas reference (Ritchie & Brindley 2007, p 411) suggested risk insurance, information exchange, and relationship building.

3.3 Risks That Can Threaten Colgate Supply Chain

The COVID-19 pandemic has highlighted the significance of creating a thorough and effective risk management strategy for your company's worldwide supply chain. You won't be prepared to

cope with potential external risks to your supply chain, such as political and economic upheaval, if you don't have a risk management framework in place. You won't be able to respond quickly enough to internal breaches in transparency and employee connectedness. International supply networks are exposed to a wide range of dangers. Here's a look at what firms are doing now - and how they're doing it.

3.3.1 Economic or Political Instability

Major shifts in global markets and the macroeconomic environment might jeopardize international commerce, putting your manufacturer or carrier partners out of business and harming your business. Political unrest may put your global supply chain at danger, especially if you utilize suppliers or manufacturers in countries that are undergoing controversial political transitions.

3.3.2 Unpredictable events

Unpredictable health and environmental disasters, such as COVID-19 or large-scale wildfires, can have a big impact on your company's worldwide supply chain. Pandemics can have an impact on a company's capacity to get items from suppliers all around the world. During the pandemic's peak, the container shipping sector was compelled to severely slash expenses, resulting in restricted capacity for transporting products around the world and substantial delays.

3.3.3 Poor connectivity

Although poor connection in your foreign supply chain is a more predictable and recognized risk than political unrest or environmental disasters, it nevertheless poses a substantial threat to your company's success. You risk restricting global chain visibility and alienating your customers if you don't invest in a system or logistics software that connects all components of your supply chain and allows you to track your product's journey to the customer's door.

3.3.4 Outdated data

Another predicted danger to your company's supply chain is sending or receiving inaccurate and outdated data, which may be readily avoided with the proper software solution. If you supply erroneous information to your contracted carrier team, they are likely to deliver the product to the incorrect location, resulting in a disappointed consumer.

4.0 Supply Chain Resilience

Increase supply chain confidence, i.e. provide the supply chain the capacity to be resilient, is one strategy to deal with supply chain risk. The key to a supply chain's long-term competitiveness is likely to be resilience. A resilient supply chain must develop resilience capabilities to respond to the negative consequences of unexpected events and quickly return to its original state, prior to the risk occurrence, or move to a new best state after being affected by the risk, and continue business operations as efficiently as possible. The goal of supply chain risk management is to increase resilience and minimize the possibility of risk events occurring (Pasman et al. 2012 p 241).

The increase in the incidence of risks that has been noticed at the global level in recent years, along with the requirement for the supply chain to be ever more competitive, has prompted managers to take steps to make supply networks more risk robust. The commercial world, as well as the scholarly press, is paying more attention to supply chain resilience. Supply chain risks are well acknowledged to have the potential to have large negative economic consequences (Hendricks & Singhal 2013 p 521]. As a result, rather than preventing accidents, resilience aids in the recovery of system states after they occur.

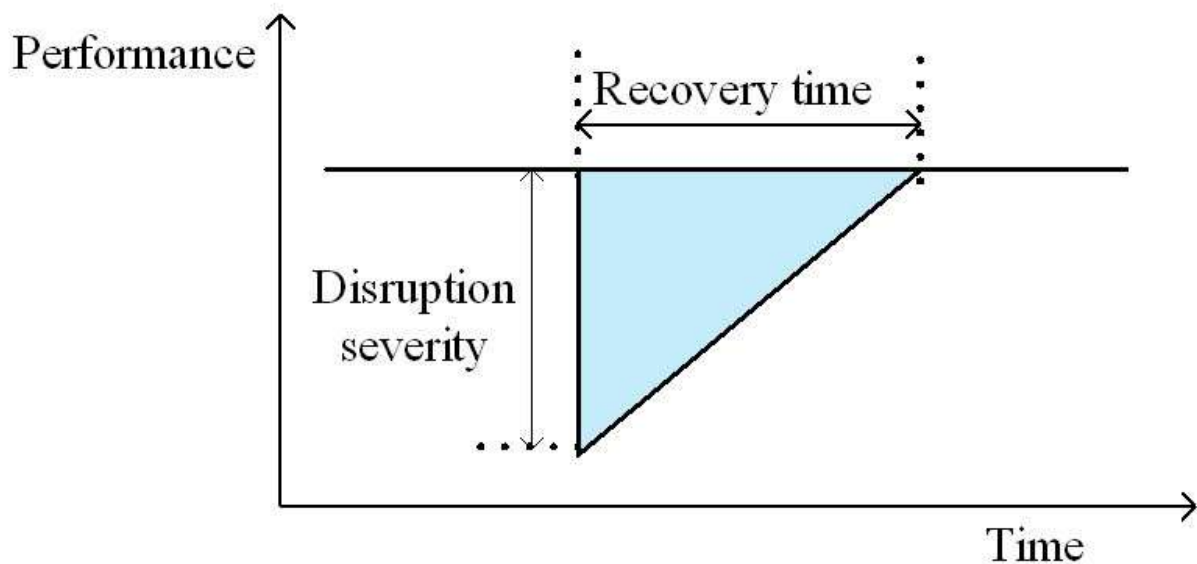
4.1 Supply Chain Resilience Assessment

There is currently no answer to the question of "how to measure supply chain resilience." Some resilience traits are listed in (Abel et al 2001, p 781): i) the degree to which the system can self-organize; ii) the ability to develop and improve the capacity for learning and adapting; and iii) the ability to construct and increase the capacity for learning and adapting. (Abel et al. 2001 p 781) further contend that in order to comprehend a system's resilience, it must be described properly - resilience of "what to what." It's critical to specify what system status and failure types are being evaluated.

4.2 Resilience Triangle

Figure 1 shows how risks effect a company's performance, which may be quantified in terms of sales, production levels, profitability, and customer service. Furthermore, the graph depicts distinct phases of the system's performance response: following a risk, performance drops, but when measures are performed, performance steadily improves. Companies' responses to risk are divided into eight phases, according to reference [20], which include i) eventual risk preparation, ii) disruptive event occurrence, iii) first response, iv) first impact, v) full effect, vi) recovery preparation, vii) recovery, and viii) long-term impact. These stages may be seen by displaying the firm's reaction to risk over time, as seen in Figure 1 by the "resilience triangle," which helps to assess the extent of the risk's negative influence on system (company or supply chain) performance. The "resilience triangle" is a disaster-related term that reflects the loss of functioning due to damage and danger. As a result, supply chain resilience may be assessed by looking at the company's performance across time.

The relationship between a disruptive event and company indicators is shown in references [59-60]. We evaluate the supply chain's goal, which is to please consumers, when selecting which supply chain performance should be examined. The length of the triangle reflects the recovery time, i.e., the damping time, and the depth of the triangle represents the disruption severity, i.e., the severity or quantity of loss damage. The firm or supply chain is more robust if the triangle is smaller. As a result, the "resilience triangle" should be as small as possible. Companies and networks' actions, behaviors, and characteristics can all help to reduce the area of the "resilience triangle" .



It is vital to apply appropriate performance measurements in this technique, which should be done according to the supply chain type. In previous simulation studies [14, 61], the authors proposed the following performance measures to analyze different scenarios in an automotive supply chain: I lead time ratio (average value of the ratio between the actual and promised lead

time for all orders delivered by a company to its direct customers), ii) total cost (sum of production, material, holding inventory, and transportation cost), and iii) fulfilment rate.

4.3 Steps to make the Supply Chain more Resilient

Because unknown threats might affect diverse areas of your company's foreign supply chain, dealing with risk monitoring and management can feel daunting. There are, however, a few critical actions you can take to keep track of and mitigate these dangers.

Measuring the importance of the carrier

Whether you utilize a common carrier or a contractual carrier to deliver your goods to your clients, you must guarantee that this carrier regularly performs well. Individual parameters such as transit time, shipment time, loading and unloading time, number of carrier delays, and average shipping prices should all be checked. If your delivery business falls short in any of these categories, you may need to switch carriers to boost your revenues. If you run a dropshipping firm or a small business that sends individual items from China or Hong Kong, you might want to look at ePacket delivery, which is a shipping service offered by third-party logistics providers (3PL) in both areas. With end-to-end tracking and simplified customs, ePacket shipping gives you more control over the shipping process. The approach was created and deployed in collaboration between China Post and the United States Postal Service, and it provides a more cost-effective way to move products fast. This can be of great help for Colgate.

Tracking of lost revenue during unforeseen events

Tracking the overall amount of income lost by your firm as a result of one of these unexpected and unforeseen threats might provide the data you need to build a more comprehensive risk management system. Colgate should also break down this net total to evaluate how much money

you've lost across the supply chain. This is a good method to zero in on areas where you can boost overall system efficiency.

Adopting a risk index value method

When developing a new risk management plan for your firm, you should assign a score to each possible risk based on the amount of threat it poses to your international supply chain. According to McKinsey & Co., this grading system should be based on three primary factors: the likelihood of the risk occurring in reality, how prepared your firm is to cope with the risk if it does occur, and the financial impact on your company if the risk does materialize. When you apply this score approach to all of the risks connected with each element of your international supply chain, you can assess which threats pose the biggest harm to your business and focus on improving the defensive structures in weaker connections.

Setting up regular reviews

After you've established a complete and successful risk management plan for your company, make sure you have a governance structure in place that assesses and considers important supply chain risks. Assemble a panel that comprises executives from all parts of the supply chain, from product designers and manufacturers to shippers, carriers, and last-mile logistics experts. That manner, you can divide down the hazards into smaller portions that can be addressed more readily. Because the specific score of each risk might change over time, it's critical to assess your risk value index on a frequent basis.

Define employee standards

When it comes to your employees' behavior, try to outline your standards. Each employee will feel more responsibility for responding promptly and efficiently to any risks to the worldwide supply chain if they have a high level of respect for your organization. They'll also take

responsibility for their mistakes and notify their line supervisors if they've misdelivered mail or provided the erroneous data to the carrier business for distribution. You'll be able to handle any hazards quickly if you have personnel that hold themselves to high standards of openness and responsibility.

Invest in an integrated logistics platform

Investing in an integrated supply chain management program or software is the greatest method to strengthen your worldwide supply chain connection. These online systems enable every player in your supply chain to access and exchange data, making the entire process visible from the beginning to the end. Response and delivery times are reduced as a result of this sort of connection. It can also help you save money and boost your company's customer relations. The company can establish a complete and successful risk management plan by using precise metrics to track carrier performance and analyze the risks associated with each segment of the supply chain.

5.0 Recommendations

Supply chain risks are rising in quantity and frequency, posing a threat to the supply chain's regular operation and stability, as well as its capacity to meet obligations. As a result, supply chains must be risk resilient in order to overcome their vulnerabilities and effectively respond to their negative consequences.

A supply chain company's risk resilience can be improved by lowering the likelihood of a disruption occurring and/or lowering the disruption's negative impacts on the supply network entity. As a result, managers must take steps to limit the risks' potentially negative impacts, whether on the directly affected firm or on other supply chain enterprises that may be harmed owing to the supply chain's interdependence. As a result, the solutions employed should reduce the negative effect of identified risks, particularly those with a high negative impact and likelihood. However, because the supply chain becomes inefficient, it is unable to develop tactics to offset any unfavorable consequences of risks. As a result, the measures used should reduce the negative impact of certain risks, such as those with a high negative impact and a high possibility of occurring. As a result, in order to implement the most appropriate mitigation techniques, whether proactive or reactive, it is required to identify possible risks in advance and quantify their potential negative impact (s). As a result, it is critical to identify not only the risks that may influence a supply chain and, as a result, their businesses, but also the risk sources.

It is basic sense to measure in order to improve. It is critical to examine the supply chain's risk resilience before developing appropriate risk mitigation techniques. Two resilience indexes, the business resilience index and the supply chain resilience index, are suggested to quantify a supply chain's resistance to a risk based on the firm's resilience index. The corporate resilience index is calculated using a performance indicator that is monitored over a period of time that

includes both the risk incidence and the risk recovery. The resilience index of a supply chain is calculated by combining the resilience indexes of its constituent companies.

Because the total supply chain performance is influenced by the performance of supply chain firms, supply chain resilience should be measured using the companies' resilience index. In this study, a supply chain resilience index is developed, which is based on the aggregate of supply chain firms' resilience indexes and follows a hierarchical approach. Because aggregation is a possible source of methodological debate in the field of index development, four options are suggested in this chapter.

The resilience triangle idea is used to calculate a supply chain company's resilience index. In general, a key performance metric related to customer service level deteriorates as a result of the risk's negative impact, and it takes some time to regain the value it had before the risk materializes. The primary performance measure's behavior over time illustrates a triangle, with the area representing the loss of supply chain company performance, i.e. the risk's negative consequences. The supply chain resilience index is created by aggregating the supply chain resilience indices of organizations using an additive model, a multiplicative model, a network viewpoint, and a constraint method.

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