

MOVING TOWARDS A RESILIENT SUPPLY CHAIN

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INTRODUCTION

The nature of supply chain management—global in scope, the existence of interdependent activities in the various processes, the need for collaborative relationships between members, and the uncertainty that is inherent in both supply and demand – makes it vulnerable to unexpected events that have the potential to disrupt operations as planned. Disruptions to the supply chain can have a profound effect on the firm ranging from loss of revenue to increased costs when operations don't proceed as planned. Firms realized that it was critical to their business interests to proactively manage, and even mitigate, the risks that are inherent in global supply chains.

In today's changing and challenging markets, it becomes paramount for supply chain managers to identify vulnerabilities and associated risks that may cause disruptions of the flows in the supply chain. Supply chains today are more complex in design and in service offerings due to global sourcing, cost reduction and lean manufacturing initiatives that have often led to fewer resources to absorb unexpected "shocks." Demand for higher standards of continuous service, both at the business-to-business and business-to-consumer level, has further challenged firms to manage and mitigate

supply chain risks through a more resilient supply chain.

Just as important as individual firm interests is the fact that supply chain and logistics management is the foundation of supply and demand. Should the process be disrupted either due to a natural disaster or an act of terrorism, the global economic foundation is impacted. Therefore it is critical to develop and build supply chains that have the capability to respond to disruptive events in such a manner that they are able to recover to their original state.

The first step in building a resilient supply chain is to define the concept itself. It is necessary to identify the components and elements that comprise resiliency. For this task it is possible to examine other disciplines where the concept has been well researched. After presenting a review of selected resilience research, this paper offers a discussion of various areas that introduce risk in global supply chains. In addition to identifying the areas of risk, the paper provides recommendations for building resiliency in each area. Finally a framework is offered to assist firms in developing a formal process for building resilient supply chains.

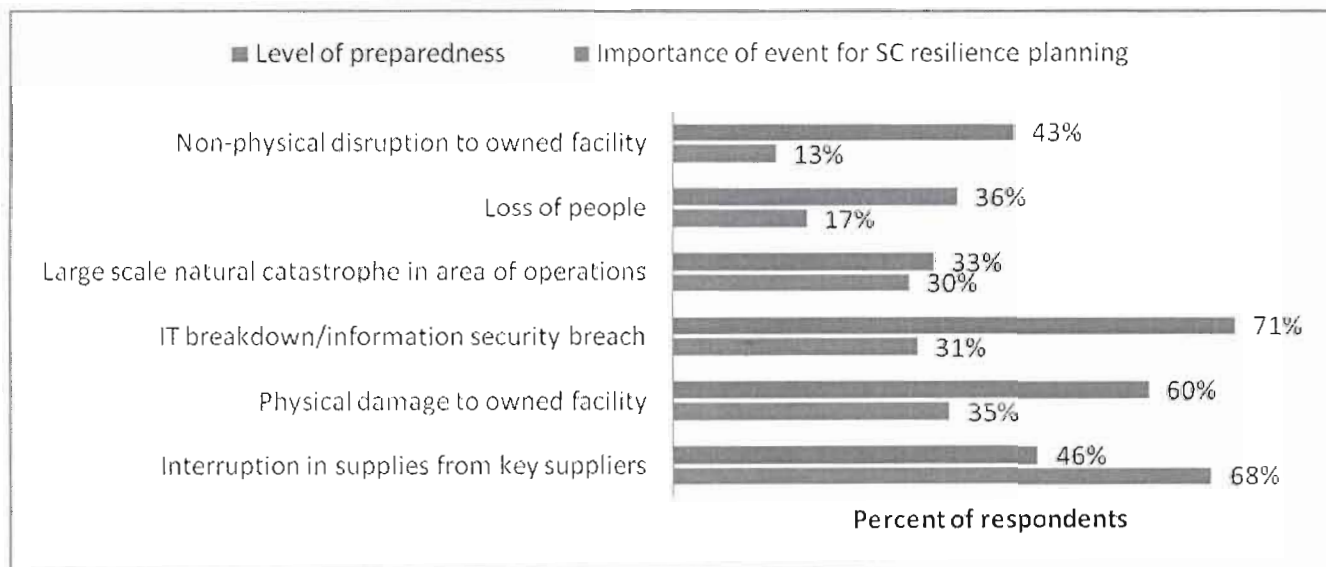
Defining Resilience

While firms have always been aware of the need to be prepared for a large scale crisis or disaster, most plan for events that are primarily internal to the organization. Data from Booz, Allen and Hamilton (2008) indicate that companies have spent the most effort in being prepared for an IT breakdown or information security breach (Figure 1). This can be contrasted to 68 percent of the respondents that stated that interruption in supplies from key suppliers is the most critical potential disruption that the firm faces. The difference between importance of occurrence and the level of preparedness is quite striking. What is clear is that firms have spent more effort on planning for events that are “within”

the firm’s control versus events that are “between” firms or boundary spanning.

It wasn’t until September 11, 2001 that businesses realized the absolute necessity of understanding something much more fundamental to their corporate wellbeing - supply chain risk and vulnerability. The interrelated and interdependent nature of business on a global scale caused many firms to recognize that critical parts of their operations were external to the organization, and in many cases outside their control. This is due in part to the nature of supply chains. They are not linear systems; instead they resemble a web in which multiple nodes and arcs exist for efficient and effective flow.

FIGURE 1
IMPORTANCE AND PREPAREDNESS FOR SUPPLY CHAIN RISKS*



* Top bar = level of preparedness; bottom bar = importance of event for SC resilience planning

Source: Lewis, Martha, Shorten and Salmon, 2008

Just as physical distribution and transportation moved to the broader scope of logistics and then to supply chain management, contingency planning and preparedness has evolved to risk management. Norman and Lindroth (2004) suggest that supply chain risk management is the application of these process tools in a collaborative manner with supply chain members to handle risks and uncertainties that are intrinsic to logistics and supply chain activities. This definition was expanded by Manuj and Mentzer (2007) to include the identification of potential sources of risk and the implementation of strategies that would reduce supply chain exposure to risk. Reduction, avoidance, sharing and transferring of risk are considered to be core elements of the risk management process. They are also important components in supply chain resilience in that it deals with multiple types of risks at multiple stages of the risk management process (Ponomarov and Holcomb, 2008). While identification of the components and elements of resilience is a critical part of defining the concept, it does not totally answer the question as to what is resilience and why is it important to supply chain management.

While resilience is a relatively new word and concept in supply chain management, it has an extensive background in other disciplines such as ecology, psychology, and emergency management. The Canadian ecologist C. S. Holling (1973) has been noted as one of the first researchers to classify two characteristics of ecosystems – resilience and stability. Holling defined resilience as the ecosystems ability to absorb changes, and stability as being the ecosystems capacity to return to a state of equilibrium after a disturbance. Since this seminal research, the concept in resilience in ecology has expanded to include other dimensions such as the magnitude of disturbance that a system can tolerate before it changes significantly (Carpenter et al., 2001). This suggests that systems have an adaptive capacity that enables them to evolve, thereby adjusting to new conditions.

Resilience has been widely researched in the field of psychology. Most commonly, resilience is defined to be the positive capacity of people to cope with stress and catastrophe (Reich, 2006). It is used to indicate a characteristic of resistance to future negative results. Furthermore, Reich surmised that the incorporation of key principles of resilience - control, coherence, and connectedness – into disaster planning would result in improved effectiveness in dealing with the event. Another important dimension of resilience was noted by Stewart, Reid, and Mangham (1997). Their research suggests that resilience is a complex interplay between certain characteristics of individuals and their broader environments. As such, resilience must have the capacity to extend across multiple levels from individuals to communities. This aspect is particularly relevant to supply chain resilience that must span from an individual company to a network of companies that comprise a supply chain.

The interdisciplinary field of emergency management offers additional insight into the concept of resilience through research on disaster recovery. It deals with issues of risks, disruptions, and recovery at a macro level rather than the individual. Resilience is referred to as one of the prerequisites for sustainable economic development (Folke et al., 2003). Lindell, Prater and Perry (2007) stated that a disaster resilient community has the capacity to learn from its experience. The learning aspect is a key part of the four stages of emergency management which includes: hazard mitigation, disaster preparedness, emergency response, and disaster recovery. These stages are directly related to building resilience consciousness discussed later.

More recently the field of computer technology has also recognized the importance of resilience. Computer networking defines resilience as the ability to provide and maintain an acceptable level of service in the face of faults and challenges to normal

operations (Xie et al., 2005). The research by Xie et al. suggests that resilience is the most important property of a networked system, and that it is one of three quality service characteristics along with security and performance.

In terms of logistics and supply chain management, Christopher and Peck (2004) adopted a dictionary-based definition of resilience that has an eco-systems foundation. This definition simply states that resilience is “the ability of a system to return to its original state or move to a new, more desirable state after being disturbed.” Perhaps the most important aspect of this definition is the acknowledgement that after a disruption a system can be different – even better – than it was before the event occurred. The idea that a system possesses learning capabilities is one that has been researched by Esper et al. (2007). They suggest that the dynamic nature of logistics capabilities enable the system to convert learning outcomes to new logistics management strategies, tactics and operations that in turn lead to the development of other logistics capabilities. Sheffi (2006) uses materials sciences as the basis for defining supply chain resilience. The ability and speed with which a company can return to their “normal” level of performance following a disruption is a measure of that entity’s resilience. This perspective does not incorporate the viewpoint of Christopher and Peck (2004) which suggests that the original state may not be achieved post disruption, but rather a new and better state than pre-disruption.

The selected review of research on the concept of resilience from the perspective of various disciplines, including supply chain management, establishes a good understanding of the properties and characteristics of this phenomenon. With this knowledge comes the question of what are the sources of disruptions for which resilience is needed? The following section enumerates some of the events that

have the potential to pose serious disruptions to supply chain operations. By identifying those things that can create interruptions to the planned flow of goods in the supply chain, managers will be able to build resiliency in their supply chains such that they can withstand and respond more efficiently and effectively to disruptive events.

Identifying Potential Supply Chain Disruptions

Managing a supply chain is a complex and challenging task. Throughout the years the number of challenges has increased as supply chains have increased the scope of markets, production locations, and sources of supply to span the world. The global reach, however, is only one of many challenges that have had a profound impact on the supply chain process. The challenges shown in the list below have the ability to significantly affect planned operations in that they are potential sources for supply chain disruptions.

- Globalization
- Carrier mergers and acquisitions
- Focus on financial discipline
- Other disruptions
 - Weather
 - Strikes
 - Global sports events
 - Pandemics
 - Geopolitical issues/pressures
 - Terrorism

Each of the challenges is addressed in detail in the following sections. Following the discussion of each challenge, a set of recommendations or a course of action is presented to assist managers in developing a more robust approach to that potential source of disruption.

Globalization

It is widely accepted that globalization is the current and future state of the marketplace. That is to say that there are no efforts and

initiatives to restrict neither the economic growth of countries nor the profitability of businesses by limiting their geographic reach. The empowered consumer is the driving force behind globalization. The consumer's demand for quality products at lower prices has driven multi-national companies to seek partners in various countries to help offset the costs of doing business. Manufacturing and sourcing from low cost regions has strengthened many companies' bottom line as well as placing increased demands and importance on the supply chain process.

The multi-national customer has and continues to demand the same levels of service and products no matter where the destination happens to be. Having consistent service and product accessibility for the multi-national customer in a global market is just as important as it is in a domestic market. Success in meeting this level of expectation falls heavily on the supply chain process.

Think globally and act locally has been the prevailing philosophy for several years. A strategic focus on supply chain principles and methodologies is being stressed to maintain efficiency, consistency, and cost containment while meeting or exceeding customer requirements. This focus generates a number of challenges for the firm, and increases the potential for a supply chain disruption due to a number of conflicting objectives. Firms can reduce their risk of not meeting customer requirements by holding higher levels finished goods' safety stock or by building redundancy into the supply chain through underutilized capacity. While this would impact service effectiveness, it would have a negative effect on efficiency measures.

The challenge of "thinking globally and acting locally" is also an opportunity for companies to build resilience into their supply chain by implementing the following:

- Allocating production in a manner that allows the firm to rapidly shift manufacturing to locations that can better meet changes in demand;
- Developing strategic relationships with critical suppliers that will support flexible sourcing;
- Using operational strategies that promote standardization through modular products and processes.

Carrier Mergers and Acquisitions

One view on carrier mergers and acquisitions is that "as long as my carrier is the one surviving the merger or initiating the acquisition, then it is a good thing and service will improve." This will only be the case if your firm is working with financially strong carriers that will not be stressed even if they are involved in a merger or acquisition. An important resiliency measure for a merger or acquisition would be whether or not it reduces (or conversely increases) the risk of service failure in your supply chain.

There are activities that can be implemented within your infrastructure to strengthen developing a resilient supply chain. These are

- Identify transportation partners that have the capability to perform the needed and specific functions for your supply chain.
- Move functions that need to be done to the supply chain member that can perform the functions effectively and efficiently—include the carrier in this equation.
- Recognize that the lowest cost carrier does not necessarily guarantee lowest landed cost.

- Keep the “big picture” in mind when selecting a carrier. A carrier that increases your resiliency is one that can expand or contract to best meet the needs of the entire supply chain and not just a portion of the flows.

Today, mergers in the transportation industry seem to happen more frequently than in the past. While much of the research suggests that many mergers do not fulfill the promises of greater efficiency and higher profitability, for the most part transportation industry mergers seem to be more successful. For example, the Yellow and Roadway (YRC) merger broadened the global scope of the carrier in making it more advantageous for the multi-national company to expand into newer markets.

Focus on Financial Discipline

A primary goal for today’s CEO’s is to increase the firm’s profitability. In many cases the key to increasing profitability begins with reducing costs. Wall Street has greatly influenced the single-minded focus on profitability by driving corporations into short-term returns for the sake of the stockholder. The concentration on short term returns has forced many long term initiatives to lose priority, and caused quick initiatives to be more on cost cutting rather than on improving core processes that would have sustainable positive impact on profitability.

An example is lean manufacturing. While lean manufacturing looks at cutting cost associated with the manufactured product, it can also raise transportation costs by changing product density factors which in turn changes rate structures of the carriers to the shipper. Lean manufacturing and lean inventory strategies can also bring in more low cost region sourcing methodologies, thus bringing more risk to the supply chain infrastructure. The answer to this issue is not the abandonment of lean principles. Rather the solution is to select and partner with transportation and logistics providers

whose operational strategies support the firm’s lean initiatives. Lean has been demonstrated to improve a firm’s and the supply chain’s flexibility. Increasing supply chain flexibility assists the firm in being able to be better to respond to disruptions. In some cases flexibility may enable the firm to avoid or mitigate the disruption to operations.

Other Disruptions

Weather. Floods, hurricanes, earthquakes, tsunamis, typhoons are weather challenges that happen throughout the world. Supply chain managers are expected to maintain operations in the best manner possible in the event of a significant weather occurrence.

Natural disasters and other weather issues are hard but not totally impossible to mitigate. The first thing that should be done is to identify the specific weather seasons, and then second, develop plans for alternative routes or modes of transport depending on the type of weather event. It seems so simple, yet many firms neglect to reduce this potential for supply chain disruption. Resilience can be built and developed in the supply chain by configuring a network that operates without the affected parts for a short or extended time period. The strength of that resiliency will be measured by how well the operations continue during the event, and by how quickly things return to a “normal” state after the event.

Industry strikes. Industry strikes are not new in today’s marketplace, but they have more of an impact on the now than in the past. Strikes happen for various reasons and they can create ripples throughout the global supply chain. The impact of a strike’s ripple effect on today’s supply chain is realized much sooner because the capacity of the logistics infrastructure is leaner and more dependent on efficiency and consistency in the operational processes. The Los Angeles longshoremen strike in the fall of 2005 proved just how fragile and dependent the infrastructure has become. Within a week’s

time of the first day of the strike, ocean container vessels were not making their return voyages back to the Asian origin ports. This caused a container back-up at the origin ports waiting for vessels to reload. As freight was shifted to air, the demand for this transportation mode in the last quarter of 2005 grew dramatically as many shippers sought to circumvent ocean shipping. Due to the high demand for freight capacity and the extremely limited capacity of the air cargo planes, on the spot buying of space was the norm and all freight rate contracts were not being honored.

What can firms do to mitigate this risk?

- Anticipate potential stoppages and develop a formal plan for shifting freight to other transportation modes. Collaborate with a freight forwarder(s) to determine how the reserve transportation capacity with alternate carriers.
- Identify critical stoppages and plan alternative actions
 - Split key shipments into smaller size shipments so modal shifting is possible and more cost effective. Conversely, develop a plan for shipment consolidation for shifting freight to modes that have greater capacity such as intermodal or rail.
 - For ocean shipments, developing flexibility in port of import and/or port of export is critical to prevent stoppages.
 - For truck strikes, review your strategy on the use of union versus non-union carriers.

Global sports. Most people would not consider a global sports event to be a potential disruption to the supply chain. Yet, this was the case when the World Cup caused a major

disruption in the import process in Brazil. In 2006, Brazil was doing so well in the World Cup series that fan enthusiasm was reaching heights of major excitement. This caused the Brazilian customs to close for five days in anticipation of Brazil's game. Timing could not have been worse. This closure happened in September—a quarter ending month. Everything came to a screeching halt pending the outcome of the soccer game. Strong and well connected freight forwarders had personnel that were able to work with the customs agents to free up the required orders and allow importation and exportation.

While all world sporting events may not lead to closure of key supply chain intermediaries, they may lead to delayed flows. Just like other supply chain challenges, this one necessitates action on the part of the firm to ensure that the flow of goods continues in the manner planned. What can you do to build resiliency in the supply chain to handle global sports events?

- The first step is simple. Follow the key sport and know specific schedules that could cause disruption to your supply chain process.
- Understand what countries your key suppliers and customers are based in and know the history of that country's position/activity in global sports.

Pandemics. Globalization has created a new awareness of how pandemic illnesses can spread quickly through the logistics and supply chain network. The Avian influenza strain like SARS, Asian flu, and most recently, bird flu has made everyone more aware of the potential outbreaks throughout the world. It is believed that an airborne influenza strain can be spread by an infected person loading an ocean container breathes the strain into the air that will be closed into a sealed container. This infected air will incubate during transit and will infect the consignee personnel when

unloading the container. This possible scenario is one that infectious disease professionals are researching.

Recommendations for building supply chain resilience for handling a possible pandemic include

- Survey your supplier and carrier base to understand what their processes and procedures are for pandemic situations. If they do not have any, work with them in getting a program started.
- Educate personnel so they know how to safeguard themselves and others against pandemic situations through a company wide initiative.
- Test out preventive actions/procedures throughout your supply chain to ensure that procedures are effective.

Geopolitical issues. Geopolitical issues should be one of the top concerns of the supply chain manager. He/she must be attuned to the political issues in the world and understand the implications to the supply chain process. More than a few U.S. firms are operating among and within countries that are not totally friendly towards them. Some of these countries have unstable political structures, and are hedging politically as to whom they should align themselves. Unfortunately, these same countries are major sources for raw materials and manufacturing activity. Civil war and military coups have become commonplace. Yet in the midst of all this turmoil, the supply chain process must continue.

What can you do to help mitigate these types of disruptions?

- Try to source product and manufacturing services from politically stable or less politically troubled countries.

- Stay up-to-date on current events. Develop contingency plans that use neighboring countries that could play a key role in assisting in the event of a geopolitical disruption.
- Maintain a very strong global network of carriers and other intermediaries.
- Make sure in-country personnel are aware of what they have to do in support of their safety and the supply chain process.

Other geopolitical challenges involve regulations and restrictions on products or shipping that can hamper the import/export process. What may be an embargoed country for your company may not be the same condition for your supplier. It is the supply chain manager's responsibility to make sure that exports from a supplier's country to other countries do not conflict with the home countries embargoes list. These types of disruptions are not pleasant and are extremely painful to overcome if caught.

Regulations on imports can change whenever it is deemed necessary by the importing country. If the paperwork does not cover the change, the import process will come to a complete stop. Something as simple as using wood pallets that have not been treated against wood boring beetles can stop a shipment and even cause it to be confiscated or destroyed by country customs for non-compliance of treated wood regulation.

Suggestions for building supply chain resilience include

- Keep current and well informed on any changes in customs that could have an effect on your product flow. If this is not possible, use a customs broker and/or a freight forwarder as a conduit for this knowledge.

- Build strong relationships with in-country import brokers. The in-country personnel should have established relationships with key contacts to work out problems incurred with customs.
- Establish a process to ensure that necessary import documents are correct and in perfect order. Surprisingly enough, a high percentage of import delays can be attributed to poor preparation of paperwork.
- Validate your export supplier's supply chain. The validation process should go as deep as possible to ensure that you know who your supplier uses within their supply chain process.
- Mandate that all carriers be C-TPAT certified at the highest status level.
- Become a partner in the U.S. Customs Trade Partner Against Terrorism (C-TPAT).

Terrorism. Immediately following the terrorists attacks on 9-11, air traffic was shut down. All U.S. borders were closed and remained so for a week and a half. Only passengers were allowed on airplanes, and even the smallest of cargo boxes remained motionless, eventually routed to a ground transportation carrier. Even the U.S. Postal System diverted mail and packages away from airplanes. After more than 70 years of being the first thing loaded on an airplane, mail and packages had to take the same ground route as general cargo. From this experience, logistics and supply chain managers have learned what can happen should another attack take place. Since 9-11 security regulations and initiatives have focused on ocean ports and borders, and have led to increased control by the U.S. government. The regulations have had a global impact on supply chains as product flows are being monitored and controlled from end-to-end.

Building resilience for ocean port infrastructure involves the following:

- Know the rules of the ports. Understand what they are planning and doing in security assistance and needs on imports and exports.
- Develop and implement a flexible port plan that spreads out shipping volume to more ports for both import and export.
- Risk mitigation for borders crossings to avoid closing issues and delays should cover:
 - Mandating that all carriers be C-TPAT certified; the higher the status level, the better.
 - Achieving the highest C-TPAT certification level possible. It is recommended that you achieve Level 3 status which gives your company primary privilege of being cleared first once a border reopens.
 - Validating your export supplier's supply chain. The deeper you go in researching your supplier's supply chain process, the greater the potential to increase your firm's supply chain resiliency.

MOVING TOWARDS A RESILIENT SUPPLY CHAIN

A review of the relevant research and the identification of the possible sources of disruptions that supply chain managers may face, leads one to conclude that several key goals can be gained by developing and building supply chain resilience. These include being able to:

- Anticipate, mitigate, and avoid any disruption in meeting delivery commitments while maintaining consistency in processes and cost effectiveness in solutions.

- Preserve the functionality of the global supply chain from sourcing to delivery in a robust and competitive manner.

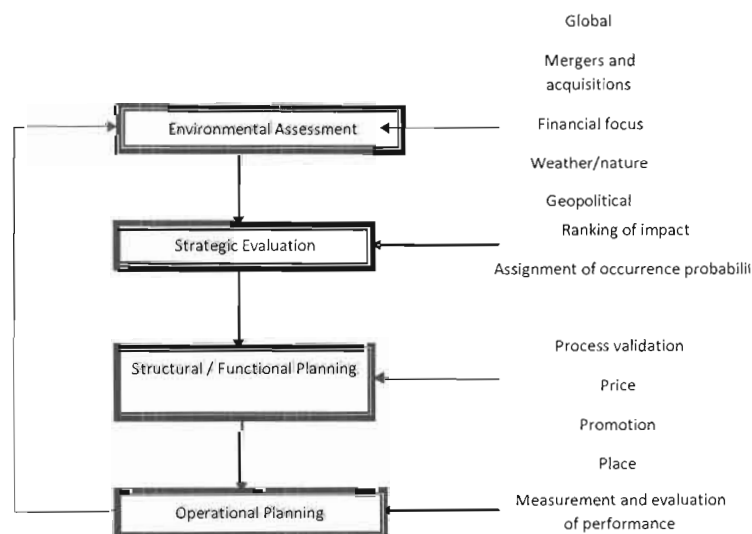
Resilience does not just happen, it has to be planned for, tested, and implemented throughout the entire supply chain infrastructure. Building and developing supply chain resilience can be assisted through the use of a closed-loop planning process. As shown in Figure 2, this process is comprised of four basic steps ranging from an assessment and identification of environmental threats to the development of operational plans for execution. The planning framework presented in Figure 2 is detailed in the following steps.

1) Anticipate the problem by conducting an environmental assessment. The fundamental justification for building and developing supply chain resilience is the assumption that the worst can happen at any given time. It is imperative that managers determine potential sources of disruption to the supply chain. This entails understanding the supply chain process from the very beginning to its ultimate end.

Areas that should be assessed for potential sources of disruption include the firm's global supply chain strategy, mergers and acquisitions of transportation providers, the firm's financial focus, and nature and man-made events such as earthquakes, hurricanes and acts of terrorism. The goal of the environmental assessment is to identify as many potential sources of disruption to the supply chain as possible.

An example of anticipating problems occurred during the 1996 Atlanta-based Olympics when a key committee was tasked with all the logistical planning to ensure that service for the Olympic Games was not disrupted. Every venue had its own level of needs and services. It was the responsibility of the logistics group to make sure that everything was done efficiently and at the lowest cost possible. Every plan was developed with the anticipation that something will go wrong and when it does, there will be a plan of action. The importance of the Games and the service demands that it generated led to the development of some 20 different solutions. There was no room for service failure.

**FIGURE 2
THE SUPPLY CHAIN RESILIENCE PROCESS**



deeper knowledge base in this area, supply chain management has just begun to understand its importance.

Although key elements of supply chain resilience have been identified, the links between them and the implications for supply chain management are poorly understood. There are abundant opportunities for future research on the topic of supply chain resilience.

The methods and approaches that are best for managing key resiliency issues are not well understood. They must be researched and analyzed in order to justify the need for resilient supply chains. The increased risks that result from complex and disperse global supply chains necessitates that companies gain a better understanding of this emerging critical area in order to effectively manage in this business environment.

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AUTHOR BIOGRAPHY

John Mascaritolo (BA in music education, Wagner College; MBA in international business, Mercer University) has more than 33 years of diversified industry experience in all aspects of transportation, warehousing, and global logistics. During his industry tenure, Mr. Mascaritolo has successfully developed and implemented many logistics programs that supported high volume and service sensitive product lines in businesses expanding consumer goods, health-care, lighting/construction industry, third party logistics industries and even event management with planning the logistics infrastructure for the 1996 Olympic Games. He is currently the director, Logistics Practices and assistant professor of supply chain management at Clayton State University in Morrow, Georgia. Prior to joining Clayton State, Mr. Mascaritolo was the commodity director of global logistics, for the NCR Corporation. He remains very active with the Council of Supply Chain Management Professional (CSCMP) on both the local and national levels. Mr. Mascaritolo was president of the Atlanta Roundtable from 1989 through 1994 and remains an advising director for the local Roundtable Board and currently is the education chair. In addition, he is an active presenter on global logistics and supply chain management to national and global logistics associations, businesses, and universities.

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