



The Vulnerability of Global Supply Chains: The Importance of Resiliency in the Face of Systemic Risk

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Executive Summary



Recent catastrophes such as the Japanese tsunami, Thailand floods, Superstorm Sandy and Icelandic volcanic ash clouds have brought to light the risks inherent with the modern global supply chain. Modern supply chains have proven cost effective and efficient alternatives to traditional business operating models, but they also increase business exposure to systemic risk. A disruption to a key customer, supplier, or even a supplier of a supplier, can cause a ripple effect with profound consequences for manufacturers, customers, other suppliers in the chain and even entire industries. Although most organizations have protocols in place to handle minor disruptions, recent events have exposed vulnerabilities that were either dismissed or simply overlooked in many organizations' quest to increase efficiency and drive corporate growth.

Supply Chain Vulnerability: A Case Study

The 2011 Thailand floods, the worst flooding experienced by the country in more than fifty years, provides a case study into the fragility of modern global supply chains. This catastrophe has become the basis for illustrating how a localized event can affect the supply chains of thousands of companies and have consequences that reverberate across the global economy.

The human impact was severe. The floods, which affected 65 out of Thailand's 77 provinces, caused significant hardship for the people of Thailand, causing significant loss of life and leaving millions displaced. In total, as many as 10 million people were affected.¹ The economic impact was also startling: total economic losses were in excess of \$45 billion and insurable losses were north of \$15 billion.²

Many multinational organizations were affected. Some, like Honda, who had thousands of vehicles flooded by more than 15 feet of water, had a physical presence with factories and inventory in the country.³ Others did not have a physical presence, but relied heavily on products manufactured there. In either case, supply chains were disrupted and losses mounted.

According to Thailand's Department of Industrial Works, the floods damaged more than 7,510 industrial and manufacturing plants, many of which were integral suppliers to large multinational organizations.⁴ Industries affected included electrical appliances and equipment, medical equipment and automobile manufacturers among others.

Computer manufacturers were hit particularly hard. Prior to the floods, Thailand had emerged as the world's second largest manufacturer of hard disk drives and, at that time, was responsible for approximately 25 percent of the world's production.⁵ Damage to production facilities resulted in global product shortages. The financial impact, which was noticeable in subsequent earnings reports, was felt by many of the leading computer brands such as Apple, Hewlett-Packard and Intel among others.⁶

The modern supply chain highlights the risk reward trade-off of efficiency versus redundancy that many organizations battle to compete in today's highly competitive global economy. If there are lessons to be learned, these catastrophes point to the need to build resiliency into supply chains as a business priority. Companies should look long and hard at their operating models and develop strategies that result in supply chains that are stable, efficient, and able to respond quickly in the event of a disruption.

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How Supply Chains Have Changed

Drivers of change

The supply chain concept has evolved in recent years. What was once simple logistics and delivery is now recognized as a driver of margins and revenue. “Kaizen,” a Japanese term meaning “change for the better,” is a way of thinking that today is often synonymous with supply chain management. Practicing kaizen means eliminating waste and, in supply chain management, the often-utilized production strategy, “just in time,” or “just enough,” does exactly that.

While “just in time” production has proven successful in driving down cost by reducing in-process inventory, eliminating redundancies, and maximizing output, the catastrophes in recent years have exposed its vulnerabilities. Carol Barton, Head of Commercial Property, from AIG’s Global Property Division notes that modern supply chains are structured to optimize manufacturing operations under normal conditions, but are not necessarily engineered to withstand catastrophic events. “Hardening operations against these exposures could introduce some redundancy into the process,” Barton explains. Although contingency planning could involve some additional cost under normal business conditions, it would help protect the company against extreme events. “In essence, the trade-off is some additional investment today to provide greater sustainability when extreme events occur in the future.”

While the Tohoku earthquake and resulting tsunami, the Thailand floods, and Superstorm Sandy have caused major supply chain disruptions, natural catastrophes are not the only cause for concern. Isolated incidents like a fire at a manufacturing facility of a single supplier also can have severe consequences. For example, an explosion at a German factory that produced CDT, a resin essential to auto parts manufacturers, impacted approximately half of the worldwide supply of the product. Such an event can set off a chain reaction of negative outcomes called “cascading failure.” Under this scenario, disruptions in one location can quickly cascade to production failures in various parts of interdependent supply chains.

Other potential sources of supply chain disruptions include terrorism, climate change effects, demand fluctuation, misguided investments, cyber espionage and political risk. For example, political tensions between China and Japan over a group of uninhabited fishing islands in the East China Sea have some worried about Japan’s automotive and consumer electronic supply chains. Anti-Japanese protests this past Fall resulted in many Japanese companies temporarily closing their factories in China because of concerns for the safety of the factory employees.⁷

Causes of vulnerability

Interruptions in the supply of vital parts or commodities can impact production and affect a business’ overall operations. The consequences of this can include a tarnished brand, loss of customers and an overall fall in revenues and share price, all of which can affect market share if not resolved quickly and efficiently.⁸ As a result, companies need to identify the sources of supply chain vulnerabilities and develop appropriate risk management strategies. Causes of supply chain vulnerabilities that should be evaluated include:

- **Outsourcing to volatile or vulnerable locations.** Businesses implementing the “just in time” approach frequently move away from local suppliers in the interest of cost. The switch often occurs without organizations fully evaluating the entire spectrum of risk associated with the transition. Many outsourced suppliers are located in emerging economies with volatile political, legal and financial systems that expose supply chains to higher degrees of political risk. They also often are in areas prone to natural disasters. For example, many of the regions impacted by the Thailand floods had only recently recovered from the 2004 Indian Ocean earthquake and tsunami. While outsourcing can be a cost effective alternative it also creates additional supply chain vulnerabilities that need to be recognized and mitigated.

A supply chain map enables organizations to understand potential causes of loss and the impact that those losses will have on them and other suppliers in the chain.

- **Limited redundancy.** Redundancy, a major driver of cost, is reduced if not eliminated by the “just in time” approach to supply chain management. While relying on lean systems reduces waste, it also can expose weaknesses in the chain. If the inventory cushion provided by higher cost redundancies is eliminated, vulnerabilities should be addressed by alternate systems or resources.
- **Failure to identify exposures.** All organizations, especially those with complex supply chains, should attempt to identify all the potential sources of disruption to their supply chains. Many companies, however, have yet to complete this important exercise or have chosen not to invest in risk management resources to fully assess their supply chains to identify potential weaknesses. According to Rob Kuchinski, Head of Energy & Engineered Risk at AIG, “many companies know who their suppliers are, but are often unaware of what redundancy that supplier has, the physical and human element loss control features of that supplier facility, or even the geographic location of the facility from which their critical supplies are sourced. Nor do they know whether or not the supplier can shift manufacturing if that one facility goes down.” Kuchinski emphasized the importance of Risk Management working closely with Procurement teams in order to completely understand the full impact of sourcing decisions.

A supply chain map enables organizations to understand potential causes of loss and the impact that those losses will have on them and other suppliers in the chain. Additionally, catastrophe risk modeling along with detailed supply chain network modeling can help quantify the range of possible supply chain losses arising from natural catastrophes.

- **Supplier of supplier:** The complexity involved with many of today's supply chains have made it difficult if not impossible for organizations to identify and understand the vulnerabilities of all of the suppliers in the chain. Even if they could identify all the links, making risk management demands of your suppliers' vendors or your suppliers' vendors' vendors is likely not feasible and usually not good business. This creates vulnerabilities that need to be addressed by alternate systems or resources. This can be addressed through supplier redundancy, taking precautions if possible to assure that the first tier suppliers are not relying on the same second tier suppliers.
- **Accumulations:** Two kinds of supply chain accumulation exposures exist; accumulations of product and accumulations of suppliers. Catastrophes such as the Thailand floods and Superstorm Sandy both provided examples of the importance of limiting product accumulations at a given location. In both cases, automobile manufacturers sustained significant losses as large quantities of inventory stored at one location were damaged due to flood waters. This vulnerability can be mitigated by reducing onsite inventory, although additional costs are likely to be incurred for maintaining alternative storage facilities and for transporting products from those sites.

Supply chain vulnerability also occurs when suppliers are accumulated in the same region or vicinity and can be impacted by a single event. In the hard drive case previously mentioned, many computer manufacturers thought they had built resiliency into the chain by contracting with backup suppliers in the event of a disruption to their primary supplier. The problem, however, was that a high concentration of hard drive manufacturers were located in the same general vicinity. Carol Barton explains, “this is an increasingly common global occurrence, particularly in Asia where industrial parks specialize in one or two key industries and therefore concentrate risk.” Mathematical models of the hazard correlation of spatially distributed systems can help quantify the risks to supply chains of supplier accumulations.

While suppliers are certainly the defining feature of a supply chain, focusing exclusively on this one facet may leave a company vulnerable to other sources of disruption.”

Assessing All Aspects of a Supply Chain

The phrase “supply chain” immediately focuses attention on suppliers. While suppliers are certainly the defining feature of a supply chain, focusing exclusively on this one facet may leave a company vulnerable to other sources of disruption, specifically infrastructure and customer damage. The following are examples of damage to each element, and the disruptions they can cause.

Damage to Suppliers (and Suppliers of Suppliers)

Damage to a supplier is the most obvious scenario for a supply chain disruption. Ordinarily, this exposure can be addressed by having multiple suppliers for each item, but this is not always feasible. Take for example the manufacturer of a pearl-luster pigment that makes car paint sparkle. The sole source of this product was temporarily shut down by the Tohoku earthquake and tsunami causing the auto industry to scramble in search of a solution. The closure impacted many of the world’s major auto manufacturers including Toyota, Nissan, Ford, Chrysler, Volkswagen and General Motors.⁹ Pharmaceutical companies are also especially vulnerable to this type of sole source or limited source supplier.

Sometimes a company does not even need to be in the direct chain of suppliers to cause disruptions. After a major supplier to the optical networking sector was knocked out of commission by the Thailand floods, Sterne Agee analysts not only cut the ratings of key customers, but also warned that the plant’s closure was likely to “impact demand for additional products that may not necessarily be even linked to” the crippled company.¹⁰

Damage to Infrastructure

For natural catastrophes such as floods, earthquakes and hurricanes, supply chain disruptions are not always a result of damaged factories and inventory, but instead a result of badly damaged infrastructure such as transportation, power and communication systems among others. For example, the inability to distribute or ship goods due to Tohoku earthquake and tsunami created a major problem for many large global organizations. In one instance, a chemical plant owned and operated by Mitsubishi was forced to suspend the supply of certain chemicals and materials due to damage sustained at port infrastructure facilities.¹¹

This event is an example of what is known as a common-cause failure. An event such as a natural catastrophe causes simultaneous failures of several components in one system which then cascade throughout the system, resulting in the failure of other components, or affects performance of components in other interdependent systems. For example, the earthquake and tsunami resulted in widespread loss of power, which rippled throughout supply chains. “In events such as the Tohoku earthquake, electric power is often affected which then impacts other infrastructure such as transportation systems,” explains Mr. Kuchinski. “Tohoku is a good example of how power failure interrupted railway and road systems which in turn impacted fuel supply and supply chain systems.”

Superstorm Sandy also caused widespread damage to the logistics and transportation networks located in the Mid-Atlantic region of the United States. Ports and terminals from Baltimore to New York were temporarily closed causing shipping carriers to either delay or reroute shipments to alternate locations. The Port Authority of New York and New Jersey, the third largest seaport in the United States and the largest maritime cargo center on the East Coast, was closed to all commercial shipments for nearly a week. Even after a month, it was only operating at 75 percent.¹² Total supply-chain interruption losses – most of which were caused by damage to transportation infrastructure –were estimated to be as high as 15 percent of the total insured commercial losses.¹³

Actual damage to infrastructure is not always necessary to cause a disruption – governmental interference can also cause logistics problems.

Actual damage to infrastructure is not always necessary to cause a disruption – governmental interference can also cause logistics problems. For example, in January 2012, Iran threatened to close the Strait of Hormuz if Western sanctions against them were to increase. The Strait of Hormuz is a strategic waterway through which 20 percent of the world's oil trade and 28 percent of liquefied natural gas exports travel. An interruption to this shipping channel would not only impact the energy industry but would be felt by businesses and consumers worldwide.¹⁴ Although the threat never actually materialized, the consequences of such government action would be severe, causing a spike in oil and natural gas prices, and potentially an increase in the rate of inflation.

Damage to Customers

The reality of supply chains is that just about every supplier is somebody else's customer - vulnerabilities exist on both sides of the chain. Damage to a supplier can delay production causing a ripple effect for organizations relying on the product. Conversely, customers who sustain damage may not be in a position to manufacture and distribute their product/s causing a ripple effect in the opposite direction. AIG's Kuchinski pointed out that companies often focus on their own suppliers, and not necessarily up the chain on their customers. However, the same type of business risks may also exist in that direction. "When considering the risk: Do you have a diverse distribution of your high margin products? Do you understand critical features of those customers, such as their business risks, the physical protection of their plants and equipment, and their Natural Catastrophe exposures, for instance?" If a company sells a relatively generic commodity such as grain, copper, or ethylene, other markets may be readily available should one of their key customers be out of business for an extended period of time. But companies selling a unique or customized product, or one that is aimed at a single purchaser, have an even greater need to know as much as they can about their customer's operations. Some companies, quite literally, have their entire balance sheets dependent upon those customers.

Supply Chain Risk Management

The Tohoku earthquake and tsunami, Thailand floods and Superstorm Sandy have helped businesses realize that catastrophic events of their magnitude are not isolated but appear to be occurring with increased frequency. As a result, companies that do not account for natural catastrophe exposures in managing supply chains are likely risking significant future losses. Additionally, the high profile events of recent years have brought supply chain vulnerability under increased scrutiny from regulators, customers, investors, and others interested in a company's performance. In a recent securities class action suit, plaintiffs alleged, among other things, that an electronics company misled investors about supply chain problems that were "increasing costs and diminishing the Company's profit margin."¹⁵ A study on the effects of supply chain disruptions on shareholder value found that companies with supply chain disruptions experience between 33 and 40 percent lower stock returns relative to their benchmarks over a three year period. Additionally, share price volatility is higher after a disruption than before.¹⁶ Directors and officers of companies experiencing disruptions are therefore potential targets for shareholder suits.

Organizations that fare the best are the ones that realize the importance of building resiliency into the supply chain. A resilient supply chain is more likely to avoid certain risks and, perhaps more importantly, it can bounce back quickly when a problem occurs. Deloitte defines the key pillars of a resilient supply chain as visibility, flexibility, collaboration and control.¹⁷

As supply chains become more complex, managing the risks of disruption and interruption have become more critical, but also more challenging.¹⁸ Progressive companies are accepting this challenge and implementing strategies to manage risk and increase resiliency by turning what could be perceived as a cost of doing business into a competitive advantage.

Risk management and operations are not mutually exclusive when it comes to managing business risks including those involving supply chains.

Many supply chain risk management strategies are well understood:

- Diversify suppliers, preferably in different geographic locations not exposed to the same catastrophic event.
- Increase redundancy: pre-identify alternative suppliers or develop strategies such as using an alternate product to fill gaps after a disruption.
- Invest in solid relationships with secure companies.
- Incorporate risk management criteria in the supplier selection process (financial strength, regulatory compliance, risk quality, risk management practices, etc.).
- Require suppliers to adhere to pre-established risk management and loss control practices. For the largest and most critical suppliers, consider building into your contracts the ability to conduct loss prevention engineering inspections to survey their key production and/or storage facilities. The same due diligence is recommended for companies selling highly specialized products, and/or products to single customers.
- Know where factories are located from which parts are sourced; high resolution geocoding will allow accurate and meaningful Natural Catastrophe analysis as well as a better understanding of other risks such as political risks or logistics.

Other factors to keep in mind when designing and implementing a supply chain risk management program include:

- **Take a comprehensive view.** Integrate the risk assessment and management of supply chain networks, as opposed to segmenting them in parts such as logistics, distribution, procurement, etc. A supply chain disruption to one segment frequently has a ripple effect impacting the entire chain.¹⁹
- **Integrate risk management into operation's process.** Risk management and operations are not mutually exclusive when it comes to managing business risks including those involving supply chains. Collaboration between departments allows for risk management input into daily operational decision making.²⁰
- **Implement supply chain modeling to identify vulnerabilities.** Supply chain modeling tools may help organizations to identify and quantify the importance of each supplier or customer along the supply chain. This information can be used to improve operations and coordination throughout the supply chain, thereby increasing resiliency and agility. History has proven that agile supply chains are far more likely to withstand major disruptions or unpredictable changes.
- **Quantify the likelihood and impact of a disruption and prioritize the risks.** Quantification metrics, especially quantifying the revenue at risk from supplier failure, enable the prioritization of risks and contribute to better decision making concerning risk management alternatives. If detailed location level data is available, catastrophe modeling combined with supply chain modeling can provide a more complete picture of natural catastrophe risks, and help to better quantify the potential financial impacts of vulnerabilities throughout the chain. This approach can provide a much more realistic and reliable view of downtime and loss from natural catastrophes as partial damage and downtime states for all suppliers can be simultaneously and explicitly assessed. Natural Catastrophe modeling also can be used to compare costs and benefits of alternative risk management strategies.
- **Actively control and monitor the risk management process.** Take corrective actions as necessary.

Some companies may go as far as to reassess their production models. "Just in time" manufacturing can be extremely effective when all goes as planned. The natural disasters of recent years, however, have proven the great equalizer by showing just how fragile this model can be. And, for some companies, this is top of mind in the C-Suite as evidenced by efforts to better understand supply chain risks and action taken to build resiliency through such measures as adding redundancy, and requesting longer contracts and supply arrangements from their suppliers.²¹

Property insurance products designed to respond to supply chain disruptions such as Contingent Business Interruption coverage, and Logistics Extra Expense are valuable risk management tools.

Risk financing and risk transfer

The Thailand floods and other events of recent years have taught the insurance industry some painful, but valuable lessons. The globalization of business and the complexity of the modern supply chain have increased the loss potential of many insurers as a result of unanticipated exposures and accumulations. Consequently, underwriters have become more cautious about underwriting contingent business interruption (CBI) risks, and typically require more information as part of the underwriting process. Detailed information on clients, key suppliers and suppliers of suppliers is often now mandatory to enable a more enterprise view of the risk. "Insurers will be least willing to provide capacity for "unnamed" suppliers and customers when little or no information is provided. On the other hand, more capacity for contingent coverages will be available when detailed supplier and customer information is provided including physical addresses of key locations that can be geocoded for Natural Catastrophe analysis, evidence of redundancy in the supply chain, and ideally the ability to conduct loss prevention engineering assessments at key supplier and client facilities," says AIG's Kuchinski.

Property insurance products designed to respond to supply chain disruptions such as Contingent Business Interruption coverage, and Logistics Extra Expense are valuable risk management tools. The coverage provided by these property policy extensions are triggered by a covered property cause of loss. Supply chain disruptions, however, frequently occur for non-property related reasons.

Disruptions caused by political unrest or as a consequence of a cyber-event, such as a distributed denial of service attack are examples of losses that would not trigger a traditional CBI policy. Coverage for these perils may be provided through specialized products such as political risk and cyber liability insurance. Risk managers should work closely with their brokers and insurance carriers to determine the optimal insurance program for their specific exposures.

Conclusion

In the aftermath of several major catastrophes, many companies have had to reassess their operating models and develop supply chain strategies that incorporate more comfortable levels of risk. The "just in time" production strategy, while efficient and cost effective, has also proven extremely vulnerable to a variety of risks. This has led to an increased focus on mitigating risk and building resiliency into supply chains, but many companies may still be inadequately prepared for a major disruption. Understanding the sources of supply chain risks, mapping and modeling supply chain exposures, and developing and implementing effective risk management strategies to minimize exposures to loss will position companies to fare much better in an increasingly challenging global environment.

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