The growing complexity of supply chain risk has demanded that companies look to a more practical framework for supply chain resiliency. Companies that succeed in constructing a resilient supply chain will earn certain competitive advantages.
As this issue of *Reason* goes to press, five-foot (one-and-a-half-meter) high flood-waters from a monsoon swamp Bangkok, Thailand, an integral location for many of the world’s multinational corporations. For those corporations, it’s a sorry sight indeed, as employees from more than 1,000 factories are getting around the city in dinghies and jet skis rather than bikes and cars.

The Thai flooding is the second reminder this year of the vulnerability of global supply chains, coming only months after the earthquake and tsunami in Japan shut down facilities that produced critical electronic components for the automotive industry. Interestingly, Thailand became a hub for car manufacturers in the 1980s and 1990s, partly because Japanese car manufacturers were seeking refuge from the fast-rising Japanese yen.

Today, Thailand’s importance to the global automotive supply chain is more evident than ever; flooding has forced Toyota, for one example, to slow production in factories in Indonesia, Japan, Malaysia, North America, Pakistan, the Philippines, South Africa and Vietnam. Honda, with more interrupted facilities in the area than any other carmaker, has also been forced to slow production in several countries. The web of commercial interdependencies appears more delicate than ever, as the forces of nature working against it are growing in frequency and strength.
“THE PROBLEMS THAT EXIST

in the world today,” said Albert Einstein, “cannot be solved by the level of thinking that created them.” This statement is certainly applicable when dealing with supply chain risk. The concept of supply chain management was developed in the 1980s, a time when the opportunity was ripe for global expansion, the foundation for the Internet revolution was being developed, and the need for cost competitiveness was a critical means of penetrating those markets. The world has significantly changed over the past 30 years. Thomas Friedman, in his book, The World is Flat, talks about “triple convergence”: the Internet revolution, the rise of emerging markets with the fall of Communism, and a new business model that competes and collaborates horizontally and vertically. As a result, supply chains have become more complex as product components may now travel thousands of miles and across continents before they are brought to the final assembly line. Outsourcing extends to manufacturing processes as well as research, development and customer service.

With any opportunity comes risk. Regardless of where a supplier is located globally, it faces operational, hazard, strategic and financial risk. The challenge is that many of these suppliers are located in parts of the world where the concept of risk management is in its infancy, despite facing the same, if not greater, risks as their clients. The growing complexity of supply chains increases the likelihood that vulnerabilities in a supply chain are hidden and often overlooked. The consequences are dire as automotive, computer components and electronics manufacturers are experiencing the wake of the 2011 Japan earthquake and tsunami. Loss of reputation and market share, intangible assets that can take years to build, can happen very quickly. As a result, corporations are beginning to rethink how they manage supply chain risk, not only in Japan, but also in emerging markets such as China, where there is a greater dependence in the supply chain and the concept of risk management is not on par with the west. (See sidebar.)

The growing complexity of supply chain risk has necessitated that companies look to a more practical framework for supply chain resiliency—one that addresses the sources of the risk rather than the symptoms—and can influence competitiveness in the global marketplace.

Unintended consequences
Disruptions to supply chains have become commonplace to the point that the financial impact can be measured in a broad sense. Since the beginning of 2010, there have been several natural disasters that have affected global supply chains: a volcanic eruption in Iceland, two earthquakes in New Zealand, an earthquake in Chile, and floods in the Midwestern United States, Australia and Thailand. These natural disasters are only a subset of all the disruptions that occur within a corporation’s supply chain.

What are the financial consequences? It takes time to assess them, but they can be severe. Price-waterhouseCoopers recently sponsored a research study conducted by Professor Vinod Singhal of
The Roads More Traveled
This supply chain footprint diagrams the complex, often circuitous production path of a basic laptop computer with earthquake zones highlighted.

Some Assembly Required
From chips and motherboards to foam packaging, the pieces required in assembling the laptop.

FM Global Earthquake Zone
Return Period of Damaging Ground Motions

- 50-year (up to 50 years)
- 100-year (51 to 100 years)
- 250-year (101 to 250 years)
- 500-year (251 to 500 years)
- >500-year (>500 years)
- Not zoned

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There has been extensive research on what is considered best-in-class in terms of supply chain resiliency. These are very consistent with the frameworks developed by professors Yossi Sheffi in his book, *The Resilient Enterprise*, and Martin Christopher at the Cranfield University (U.K.) Centre for Supply Chain Risk and Resilience, Cranfield School of Management (Figure 2).

This framework was the result of an exploratory study of supply chain vulnerability by the Centre for Logistics and Supply Chain Management, undertaken in 2001 on behalf of the U.K. government’s Department for Transport, Department of Trade and Industry (DTI) and the U.K. Home Office. The impetus for the study was the widespread economic disruption experienced in the United Kingdom by fuel protests in September 2000 and by the outbreak of foot and mouth disease in February 2001. The framework deals with the sources of risk within the supply chain.

Emerging from the research programs are a number of discernible general pillars that underpin resilience in supply chains. In particular, there were four principles or pillars that are the most critical to resiliency. The authors suggest that all four pillars need to be in place for an effective supply chain risk management program.

### Supply chain engineering

Supply chain risk management needs to be integrated in the design of the supply chain. Certain design principles came out of the research, namely, the choosing of strategies that keep alternative options for sourcing and the efficient vs. redundancy tradeoff: Should I carry more suppliers’ inventory as a buffer to a disruption? The supply base strategy—namely, the way in which a company sources, is another key component: the choice of single sourcing or multiple sourcing and the criteria used in the selection of sourcing partners. The third component is having a fundamental understanding of the network that connects the business to its suppliers and their suppliers and to its downstream customers. Mapping the supply chain would be a means of obtaining that understanding.

### Supply chain collaboration

Cultivating a transparent relationship between company and supplier that enables the supplier to work with the company in assessing and mitigating the risk is critical. The busi-
Once those vulnerabilities are identified, they can be managed appropriately. To achieve this will require the company to change its paradigm about supply chain risk: the goal toward resiliency needs to become a corporate- and supply chain-wide effort. Company management must view supply chain risk management as a competitive advantage. A framework where resiliency is factored into the design of a supply chain, where open collaboration exists between a company and its suppliers, and supply chain’s agility and flexibility is built into a risk management culture, is a long-term vision for companies to consider.

The world is rapidly changing. Uncertainty has become the norm. Those who manage that uncertainty within their supply chain will be the winners and create a real and sustainable competitive advantage.

**FIGURE 2:**
Creating the Resilient Supply Chain

Source: "Building The Resilient Supply Chain," Cranfield University White Paper, Martin Christopher and Helen Peck, 2004
Develop a Risk Intelligence System
and other good advice…

Richard Wilding, an award-winning authority on globalization, provides an insider perspective on building a better supply chain

For a more in-depth perspective on the supply chain framework, Reason magazine spoke with a key contributor to its development. Richard Wilding, professor of supply chain strategy at the Centre for Logistics and Supply Chain Management, Cranfield University (U.K.), is an acclaimed presenter on the subject and often facilitates workshops and conferences. Wilding was a winner of the “Individual Contribution Award” at the “European Supply Chain Excellence” program in 2010, presented to an individual who has made an outstanding contribution to supply chain excellence.

What is the state of supply chain resiliency in the corporate world?

Wilding: It is a bit of “hit or miss.” Some companies have strong resiliency while others have a long way to go. In recent years, the concept has received greater attention as the impact of supply chain disruption on shareholder value has become more evident. Senior management at many global companies take the attitude, “It is not going to happen to me,” and getting them to realize the consequences can be a great challenge.

Overall, supply chain disruption is very difficult to predict in order to employ the appropriate contingency plan. People do not plan on uncertainty. However, they should be developing contingency plans on disruptions regardless of their source. Knowing the underlying trends for such an event to occur is critical to understanding what types of disruptions can occur. For example, if you know that a category 5 hurricane can potentially hit your area, you should know the consequences and plan accordingly. You should be aware of how the government will react to such an event and while you cannot control its response, you can control yours.

What are some of the most common wrong assumptions that companies make concerning their supply chain risk?
The most common wrong assumption is that the supplier will have the same perspectives on risk as that of the customer corporation. More often than not, when you ask the supplier—through a risk audit—what risks they have, they will come up with a different set of answers than the customer corporation. Often corporations will send out a supplier questionnaire, and they will tick a box about their risks and risk management programs without having that common view. That leads to a false sense of security by the corporation.

Identifying and assessing risk is a very subjective process. Corporations need to establish the commonalities before conducting their audits.

How has the concept of supply chain resiliency evolved since you began working on it?

In the 1990s, supply chain risks were viewed as internal to the corporation. They were most concerned with demand-side volatility and the “bullwhip effect.” The year 2000 seemed to be a watershed point. The Y2K issues and the fuel crisis that took place in the United Kingdom began to demonstrate the ripple effect of disruption to various, seemingly unrelated industries. The source of the fuel crisis was the imposition of a level of tax on fuel for trucks that was not equal to that of the rest of the European Union. This led to blockades by truck drivers in the United Kingdom that resulted in the lack of availability of food in supermarkets that in turn led to consumer panic. This event brought home to executives of U.K. corporations that an external disruption such as the blockade would mean that “you are only three days away from public panic.”

How did this evolve into the concept of resiliency becoming a competitive advantage? It was based more on a few events. First, a study by Professor Vinod Singhal of Georgia Tech, demonstrated the adverse impact of supply chain disruptions on a corporation's share price. Second, in 2005, there was a warehouse fire of a major U.K. clothing manufacturer, Primark, during the...
Christmas holiday shopping season where they were able to respond within a few days to find an alternative warehouse adjacent to the damaged one, rent a large cargo transport aircraft and quickly replenish the warehouse with new clothing from their suppliers in the Middle East. The share price had gone down 50 percent immediately after the fire, but recovered shortly thereafter.

The board of directors and senior management of many corporations do not view the investment of supply chain risk management as having a return. They do not see a disruption happening on their watch. In order to get them to buy into the concept, you need to demonstrate the financial consequences of the loss of competitiveness.

What was the research that you undertook to come up with this framework for supply chain resiliency?

The framework was developed in 2001 and was the result of two initiatives. First, the “Cranfield Agile Supply Chain” concept came out of coping with volatile demand. The concept of dealing with volatile demand in lean supply chains came from Toyota in the mid-1990s. We determined that the principles of managing lean with demand volatility are the same for supply chain disruptions, except the volatility those companies were dealing with was plus or minus 1,000 percent.

The second was the “Collaboration” concept. This was the result of an extensive search that demonstrated the greater the collaboration with suppliers on managing volatility, the greater the ability to respond to disruptions. The key event in this search was the Aisin Sieki fire that affected Toyota’s supply chain in 1997. The fire shut down one of the production facilities of a Toyota subsidiary that produced the brake fluid valves for most of their cars. Due to the “just-in-time” stock-keeping philosophy of the Toyota Production System (TPS), Toyota’s car factories reportedly only kept four-hour stocks of the part. With the factory out of production, it was estimated that Toyota would have to halt car production for weeks. The economic impact of this would have been huge for Toyota, the local economy and for Japan. It was estimated that each day Toyota production was halted would lead to a 0.1 percent decrease in Japan’s industrial output. They approached their suppliers to collaborate on how to solve the problem together by indicating that additional suppliers’ survival was also at stake. The event provided an example of successful business relationships between Toyota and its suppliers, allowing the company to quickly manufacture replacement parts and limit the halt in production of its cars, so minimizing the losses from this event.

The lessons learned from these initiatives also identified the other two pillars to supply chain resiliency: supply chain engineering and a supply chain risk management culture. The engineering pillar talks to the need to integrate risk management into the design and the structure of supply chains, the sourcing policies and information technology. This, in turn, enhances the level of agility and collaboration with suppliers. The risk management culture is a function of ensuring that when management makes decisions about supply chain partnerships, risk management is a key consideration. If the corporation decides to change partners, it needs to understand the upstream and downstream consequences on risk. Sadly, many corporations do not ask this question.

How has this model evolved over time?

We conducted further research to determine how this framework should be implemented in a corporation. The foundation requires developing a sound supply chain management strategy that fundamentally considers risk management in its business processes, infrastructure, information systems, and its organization. It is about sustaining the value created through the supply chain.

Next, the corporation needs to ensure robust product designs so that risk management is adequately addressed to minimize volatility in the production process. Third, they need to employ the four pillars—agility, supply chain engineering, collaboration and a risk management culture.

And, finally, the corporation needs to develop a risk intelligence system that monitors underlying trends and provides an early warning to the organization in order to be prepared for an imminent disruption. Of course, the key to all of this is ensuring transparency within the supply chain.

In your opinion, who were the winners and losers of supply chain disruptions from the Japan earthquake?

It depends. In some cases, the consumer is the winner and in others it is the loser. Take the automotive industry, for example. In the luxury car segment, the consumer was the winner as evidenced by Mercedes offering upgrades on the options at a significant discount, while in the economy car segment, there was not a lot available and so the consumer had to pay a higher price.

One of the lessons learned by corporations from the earthquake is that companies had “too many eggs in a single basket.” They are now beginning to reconsider their sourcing strategies by diversifying across countries or undertaking local sourcing to mitigate the risk for disruption.

How do you see the concept of a competitive and resilient supply chain changing over the next ten years?

Supply chain risk management will become a greater board level/senior management concern. It will become part of “business as usual.” Corporations are beginning to realize that market uncertainty is on the rise. We are moving from an era of the plenty, where we can be selective in the suppliers we deal with, to an era of resource pressure, where we need to think carefully of where and with whom we establish sourcing partnerships. [R]
Pardon the Interruption

The surprising results of a senior executive supply chain risk study: “China and Natural Disasters – A Case for Business Resilience”

The Japan earthquake and tsunami of March 11, 2011, was a wake-up call for many global companies, according to a survey of senior financial executives at those firms. Many now seem to realize that if a similar earthquake and tsunami occurred off the coast of China, the worldwide impact to supply chains could be much worse.

With China being a major economic center and supply chain hub exposed to many of the same natural catastrophe threats as Japan, many multinational companies say they are concerned about their operations in this fast-developing country—a region that has not yet fully embraced the risk management practices of its western counterparts.

Many global corporations have taken note of the business interruptions caused from the Japan earthquake and tsunami and are looking more closely at their potential exposure in China. But is it enough for companies to just reassess their exposure, create more supplier collaboration, and broaden their supply chain network?

The increased concern for supply chain risk in China underscores the need to look at supply chain resiliency beyond just certain risk management tactics and geography. It is more fundamental and strategic. The commitment to supply chain resiliency starts at the top of an organization. The most progressive organizations view supply chain resiliency as a competitive advantage.

Key Findings

1. Nearly 9 in 10 companies (86 percent) say they are more reliant on China as part of their supply chain for their key product lines than they are Japan (43 percent). (Figure 1)

2. An overwhelming majority of companies (83 percent) consider supply chain disruption to be a “moderate” to “greatest” risk overall, considering all the factors that can affect the financial well being of their organization. (Figure 2)

3. As a result of the Japan earthquake and tsunami, 94 percent of companies reliant on China for their supply chain are concerned about natural disaster related supply chain disruptions to their key product lines in China.

   • 61 percent of those companies say they were “somewhat” to “extremely” concerned about supply chain disruptions to their key product lines in China, prior to the Japan earthquake and tsunami. (Figure 3)

   • 39 percent of those companies say the Japan earthquake and tsunami has increased their level of concern about supply chain disruptions to their key product lines in China. (Figure 4)

   • 56 percent of those companies say they still have the same level of concerns as they did before the Japan earthquake and tsunami. (Figure 4)

4. More than 6 in 10 companies reliant on China locations are looking at their supply chain risks there with more scrutiny as a result of the events in Japan.

   • 61 percent of those companies are considering “implementing a more robust risk assessment process” to mitigate their supply chain natural hazard exposures for their key product lines in China. (Chart 1)

   • 65 percent of those companies are considering “increasing collaboration with suppliers on mitigating risk at their locations” to mitigate their supply chain natural hazard exposures for their key product lines. (Chart 1)

   • 70 percent of companies reliant on China are considering “increasing alternative sourcing” to mitigate their supply chain natural hazard exposures for their key product lines. (Chart 1)
Figure 1: Reliance upon Japan or China as part of the supply chain for key products lines

Figure 2: Level of risk of supply chain disruption overall

Figure 3: Level of concern about supply chain disruptions in China before the Japan earthquake

Figure 4: Change in level of concern about supply chain disruptions in China since the Japan earthquake

Chart 1: Post-earthquake strategies being considered to mitigate supply chain natural hazard exposures for key product lines in China

- Increase alternative sourcing
- Increase collaboration with suppliers in mitigating risk
- Implement a more robust risk assessment process
- Increase in-sourcing
- Change supplier acquisition
- Carry additional inventory
- Other means
- Purchase more insurance for supply chain business interruption
- Relocate any operations
- Redesign manufacturing processes
- Redesign products
In such organizations, a supply chain disruption is viewed as not merely a threat, but as an opportunity to gain market share. Once a company loses a client due to a lack of product availability emanating from a supply chain disruption, it could lose that business for good.

In particular, resiliency that is sustainable is about establishing a corporate culture that encourages forward thinking, designing products and manufacturing processes that incorporate supply chain risk, building collaborative relationships with suppliers to mitigate risk, and having the agility to quickly and effectively deal with a disruption as a result of robust business continuity planning.

“The findings in this report point to how interdependent risks can have severe financial consequences in global supply chains,” says Dr. Howard Kunreuther, the James G. Dinan professor of decision sciences and public policy at the Wharton School of the University of Pennsylvania (USA). “Successful mitigation of interdependent risk is strategic in nature and involves the entire organization, including key external business partners. More specifically,” Kunreuther adds, “firms need to undertake proactive measures, such as finding several sources of supply so that they are not dependent on one company that may be adversely affected by a future natural disaster. Finally, there needs to be a realization that the process of developing a resilient supply chain takes time.”

“The findings of the study should be a wake-up call for companies that have substantial investment and dependency on supply chains in China,” says Vindo Singhal, Brady Family professor of operations management at the Georgia Institute of Technology’s College of Management. “A natural disaster-related supply chain disruption there would have far-reaching negative economic impact. It would slow down the global economy, as China is not only a major exporter of goods, but also a major importer as well.” [5]

The Japan earthquake has given rise to many stories of financial loss arising from disruptions to supply chains; however, in the aftermath of such an event, risk executives all around the world need to consider and learn from some of the more positive stories. These stories are of those companies exposed to the disaster, and through careful strategic planning and appropriate risk management not only survived, but also seized the opportunity to turn survival into a competitive advantage and emerge on the other side in even better shape than before. Here is one such story.

“Company A” is a global computer manufacturer. “Company B” is a global semiconductor manufacturer. Both firms have primary manufacturing locations in the United States and export their products to consumers all over the world.

Both companies also rely on a similar, complex global supply chain that includes the supply of a product called silicon wafer, which is an essential ingredient in the manufacturing process of semiconductors. This means that both companies are vulnerable to the risk of any disruption to its continuous
wafer supply, and that product manufacturing can affect their operations significantly.

When an earthquake hit off the eastern coast of Japan’s largest island on March 11, 2011, the primary suppliers of silicon wafer to both Company A and Company B suffered extensive damage to their manufacturing facilities and were immediately unable to meet their procurement obligations to both Company A and Company B. For those charged with managing risk in their organizations, this is where the story gets interesting.

Like most sophisticated organizations, Company A had followed appropriate risk management processes and identified that the silicon wafer supplier in Japan was critical to the supply chain and any disruptions to the supply of silicon wafers was likely to have a significant negative impact on the company’s ability to maintain normal operations and deliver its products to the market.

As part of what Company A has perceived to be an appropriate level of risk management, they had also recognized the need to develop suitable business continuity plans that were ready to be invoked to minimize any possible disruption following any event that caused a disruption to their wafer supply. The problems for Company A following the quake began when they realized that their secondary supplier of silicon wafer, selected in their continuity plan, was located in the same region of Japan as the primary supplier and had also suffered major damage.

Despite good planning and what appeared to be a robust strategy for managing this particular supply chain risk, Company A found itself with no primary or secondary supply of a critical component in its supply chain and with a desperate need to find a new supplier in a market where demand suddenly significantly exceeded supply.

Unfortunately, this process took more than a month to source, during which time remaining inventory levels were exhausted and significant parts of the manufacturing process came to a halt.

In following a similar structure for understanding and analyzing supply chain risk and developing strategies for mitigation, Company B thought beyond the basic need for a business continuity plan and recognized the need for geographic diversification of alternate suppliers. As part of its contingency planning, Company B made a strategic decision to engage a secondary supplier in Canada to substantially increase volumes of silicon wafer if the primary supply from Japan was disrupted. This, of course, ensured that the required volume of the supply was maintained.

Within a week of the Japan earthquake, Company B was able to advise the market that, despite the material global decline of silicon wafer supply, business continuity plans had been put into action and there would be no material impact upon production and no disruption to supply of end products to consumers.

In the two reporting quarters since the Japan earthquake, Company A has attributed nearly US$100 million of losses to disruptions resulting from the Japan quake and has advised of a loss of approximately 3 percent of market share over that same period. Conversely, Company B has reported a 10 percent rise in net profit and a market share increase of 1.9 percent in Q2 2011 alone.

When it comes to understanding and managing supply chain risk, the question risk executives need to ask themselves is: Is your organization well prepared like Company A, or has your company conducted comprehensive analysis, like Company B, to truly understand supply chain exposures and created robust business continuity plans with sound risk mitigation strategies to ensure survival—and possibly even generate value—during a major disruption? [n]

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