ONLY AS STRONG AS THE WEAKEST LINK

The waves from the tsunami that followed the Sendai earthquake had hardly receded before its economic impact began to be calculated. This isn't because of callousness on the part of economists and logisticians; we all recognize the tragic loss of life and the hardships to be faced by the survivors in the disaster zone. But a string of recent megadisasters—from the September 11 attacks in 2001 and the Indian Ocean tsunami in 2004 to Hurricanes Rita and Katrina in 2005 and the Haiti earthquake just last year—have brought home the point that the world is far more connected than it was even 30 years ago.

Supply chains, which provide raw materials and distribute finished goods to end customers, now extend through many independent companies, and nearly every chain is global. As a consequence, major events from around the world, both natural and man-made, affect the flow of goods and have an increasingly sharp and visibly evident impact on businesses—and ultimately on consumers.

In a very real sense, the effects of those sorts of disruptions are a signal that some new methods are required to manage the new risks that firms are exposed to today. While much of the physical destruction from the recent earthquake and

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ILLUSTRATION BY BENJAMIN BOBKOFF

As the effects of the Sendai earthquake and tsunami ripple through the global economy, companies should shore up their supply chains to guard against disaster.

By James B. Rice

tsunami were unavoidable, it is apparent that some of the business impacts could have been mitigated, if not avoided.

While businesses have embraced the advantages of global supply chains, there is a critical need to manage the new vulnerabilities that come as a result. Companies need to consider creating action plans in order to manage the risks arising from the inevitable disruptions that significantly affect business operations and supply chains. Failure to do this could leave companies every bit as fragile as the supply chains they rely upon.

The aftermath of the March 11 temblor has set off a series of system breakdowns, much the way one tipped domino can lead to the toppling of hundreds of others. The earthquake and resultant tsunami collapsed facilities and damaged infrastructure in a huge swath of northeast Japan. One of the damaged facilities, the Fukushima Daiichi nuclear power plant, created its own set of problems with a release of radioactive material, while other nuclear power plants were kept offline as a precaution. The loss of power from those plants could not be made up easily, so power outages and rolling blackouts were common for weeks after the quake. These outages crippled operations in many local businesses, and energy shortages led to transportation system failures and constrained cargo movements, which led to delays in providing goods for health care, humanitarian aid, and business needs.

In the immediate aftermath, there was a lot of uncertainty. Most downstream customers did not have a full accounting of their dependence on material supply coming from northeast Japan, and there was some wild speculation about what could happen. Many companies discovered some unexpected vulnerabilities because they were dependent upon material supply coming from the affected region. The effects quickly spread beyond Japan and began impacting businesses outside the region and throughout many downstream supply chains, where the manufacturers serve as core suppliers.

Of the businesses affected, there is a large concentration in the automotive and high-tech industries. The region most damaged by the earthquake effectively served as a supplier hub where many companies co-located close to their customers to provide high levels of service and rapid supply. What surfaced in the aftermath were significant dependencies for several materials and components that were primarily produced by one company or several companies located in the region.

For instance, a Hitachi Automotive plant shut down by the earthquake produced a $2 sensor that is part of a $90 airflow sensor used in engines for many vehicles. Because of the halt in production, a General Motors engine plant in New York ran short of parts and downstream GM vehicle assembly plants in Europe and the U.S. had to be shut down.

Similarly, Apple's iPad 2, which launched on the same day as the earthquake, depended heavily on five material supplies from the region, in particular a polymer resin used in making the batteries. A single company in the region makes 70 percent of the world supply of one material. While the full impact has yet to be felt, supply delays are expected to exacerbate the shipping delays Apple has experienced to date for the iPad 2. Indeed, weeks after the launch, prospective buyers lined up each morning outside Apple Stores to purchase whatever stock had arrived overnight.

We can expect many more supply issues given the high concentration of critical material supply coming from Japan, and in many cases, from the affected area itself. Global silicon wafer supply lost 25 percent of capacity because of damage at two key facilities. Renesas Electronics, which produces 40 percent of the global supply of microcontrollers for drive trains and other automotive purposes, shut down operations in its plant in Hitachinaka, and expects the facility will remain closed until July. While it's predictable that there will be significant downtime and delays for the customers of those shuttered plants—and that this will have a domino effect on all of the businesses in their expanded supply network—the disruption also translates into a market opportunity for those businesses that can serve the disrupted supply.

It is conventional wisdom that the chain of disasters following the Sendai earthquake is unique, and indeed, there were some uncommon elements to it. Unfortunately, the sad reality is that this disaster is no different from nearly all other disasters in terms of outcome. To be sure, the earthquake-tsunami-supply hub destruction-nuclear meltdown combination has not been seen before. But after the destruction, there was predictable loss of life, damaged business assets and infrastructure, communication system outages, transportation constraints, and resource shortages. These are among the common outcomes that result after every disaster, regardless of the nature of the disaster or disruption.

Of course, there are elements that have magnified the effect of this disaster in the global economy. The affected area was much larger than most disasters, and with the region serving as a supplier hub for the automotive and high-tech industries, there was an unusually large concentration of businesses that were disrupted. (Contrast that with the tsunami in 2004 that hit Banda Aceh in Indonesia and then washed across the Indian Ocean: while both tsunamis devastated large areas, the 2004 tsunami had no significant impact on global business operations.)

This is a first high profile instance of a significant disruption to one of the major supplier hubs; these hubs have emerged on a large scale only in just the past 20 years. What's more, many of the affected companies were not only regional suppliers, but also global suppliers with large market shares. The sheer number of impacted businesses and their extensive downstream supply chains also make this disaster different and the global ripple so significant.

But aside from the scale, which is several factors larger than most disruptions, the generic outcomes from the Sendai earthquake and tsunami were readily predictable: a disruption occurred and the affected companies were not able to serve their customers. They lost their ability to receive materials, to communicate with their employees, to

EARLY REPORTED IMPACTS FROM THE SENDAI EARTHQUAKE AND TSUNAMI

COMPANY	PRODUCT	CORE CAPACITY LOSS (FAILURE MODE)	BRIEF IMPACT
APPLE	iPad 2	Expect loss of supply	Key component suppliers shut down (NAND flash memory, touch screens, iPad batteries)
FREESCALE	Accelerometers, pressure sensors and other chips	Loss of internal capacity	Plant in Sendai shut down, shifting production to other facilities
GM	Automobiles	Loss of supply	U.S. plant closed because lack of supply of engine air flow sensors
HITACHI	Engine air flow sensor	Loss of internal capacity	Plant damaged
HONDA	Finished vehicles, auto components	Loss of supply	Dependent on 10 suppliers located in radiation zone; closed three component and two assembly plants; lost contact with 44 of 113 suppliers
MAZDA	Finished vehicles, auto components	Loss of supply	Plants closed, some closed through April
NIKON	Cameras	Loss of internal capacity	Plant closed; only plant making SLR cameras
NISSAN	Finished vehicles, and engines	Loss of internal capacity, loss of supply	Facility closed due to lack of water, electricity, and gas; considering sending engines from Tennessee plant to Japan
ON SEMICONDUCTOR	Semiconductors	Potential loss of internal operations	Temporary shutdown at several facilities
PORTS IN JAPAN	Various	Loss of supply	Estimated cost of port closures $3.4 billion
POWERCHIP TECH.	DRAM	Loss of supply	Redesigning product to use available supply
RENESAS	Drive train microprocessor	Loss of internal capacity (clean room)	Facility closed; many auto companies dependent on this product
SHIN-ETSU CHEMICAL	Silicon wafers	Loss of internal capacity	World's largest maker of silicon wafers disrupted; 57% of world's wafers come from Japan
SONY	Rechargeable batteries, DVD, Blu-ray discs, lasers	Loss of internal capacity	Closed 10 factories
TOYOTA	Finished vehicles	Loss of supply parts, loss of internal capacity	Shutdowns across all Toyota plants; expected loss of 140,000 units; Prius only made in Japan

FAILURE MODES

While the types of disruptive events seem unlimited, there are only a few actual outcomes that affect a business. And since these outcomes are essentially ways that a system can fail, we at MIT's Center for Transportation and Logistics refer to them as "failure modes."

From our research, we have identified six different ways that a supply chain can fail:

Capacity to Acquire Materials

This mode mainly includes loss of sources of supply or the availability of materials.

Companies told us they focused their business continuity plans on backing up their suppliers with qualified second sources and developing backup plans with sole sources.

Capacity to Ship or Transport

This mode mainly entails the loss of the ability to move materials, such as supplies, work-in-progress, finished goods inventory, and consumables.

Companies told us they added backup plans for transport. Some have set up contracts with other third-party logistics providers to have a backup ready.

Capacity to Communicate

This failure mode mainly includes loss of the ability to communicate both internally with employees and externally with suppliers and customers.

Most of our respondents relied on traditional IT backup as primary source of resilience against this type of failure.

Capacity to Convert

This mode involves failure of the internal operations of the business, including factory production and distribution operations. Such a failure could be caused by the loss of utilities due to an accident or by the loss of inventory through damage or quality issues.

Some companies have contingency plans to back up their internal operations, such as having outside suppliers make their products in the case of an event at their own plant.

Capacity to Use Human Resources

This mode encompasses the loss of human resources to carry out the various operations.

Respondents have looked at how they could back up their key human resources. Some firms have broken manufacturing work into small pieces so that untrained personnel could come up to speed quickly.

Capacity to Tap Financial Flows

This mode primarily involves the loss of access to capital and cash flow. It may occur through a decline in customer demand or a demand spike that stresses the supply chain.

have employees available to work, to obtain the necessary financial flows to fund operations, to make products, and to transport goods to customers. These six capacity losses are predictable impacts and encompass all possible outcomes, in terms of lost capacity from all kinds of disruptions.

The scope of the disruption was certainly no different from scope of disruptions in the past. For example, when Hurricane Rita disrupted petroleum operations in the Houston area in 2005, the result affected supply chains around the globe in many different industries—not only end users of petroleum products but also distant packaging firms and tire manufacturers, among others.

These days, we are all aware of supplier hubs, logistics hubs, and industries concentrated in a specific geographic location. So in the aftermath of the Sendai earthquake, many companies initiated their backup and contingency plans and many others were in the process of looking for backup supply (though it is not a good time to be searching for additional capacity when everyone else is also looking). We should expect prices to increase on many materials, supply cycles to be extended, and some materials to be hoarded.

Another predictable outcome is that many companies will avow a focus on business continuity planning and will give serious thought to their vulnerabilities. Yet if this is like most disruptions, the introspection will last only for a little while. Among the many companies examining their vulnerabilities, only a few will take serious action to prepare for the next disruption. Usually it will be the companies that have suffered serious impact that take action.

So what can we learn from this? If anything, it is another wake-up call for organizations to seriously consider supply chain risk management and the need for business continuity planning. This disaster and its fallout present a fresh recognition of vulnerabilities that exist in many supply chains.

Close scrutiny of upstream dependence is a necessity. Specifically, businesses should look at how dependent they are on a single geographic region, such as a supplier hub, on a single supply source, and on a single material with an embedded or highly concentrated supply. While those sorts of dependencies are not new, they represent vulnerabilities that have been revealed through the impact of this recent disaster.

Additionally, the complexity of extended supply chains is extremely high and requires methodological diligence. Supply chain mapping tools may be helpful to capture, monitor, and analyze the extended supply chain footprint, including supplier locations, supplier stability, and interdependencies among suppliers and contractors.

Given the world as we know it today—globalized and increasingly integrated—it's not a question of whether there will be disruption in the future, but when, where, and how the supply chain will be disrupted. The "secret" for successful response to disruptions is to prepare before the event occurs. This may sound obvious, but for most this is not evident until a disruption occurs and the actors realize that their ability to respond is nearly completely dependent on resources, systems, and plans that they made months and years earlier. Once the disruption happens, it's well-nigh

impossible to secure critical resources.

When planning a response to supply chain disruptions, some considerations are particularly productive:

Identify the supply chain footprint.

Companies should identify their entire upstream supply chain—not just their tier one suppliers but all suppliers and sub-suppliers. They should try to understand their downstream customers and intermediaries as well.

Assess vulnerabilities.

Businesses should conduct a vulnerability assessment for their extended supply chain, not just internal operations. This includes assessing geographic risk (whether suppliers are all located in the same area), assessing organizational risk (whether a component is sole sourced), assessing embedded risk (whether the various suppliers are dependent on a common material source), and assessing supplier risk (whether the supplier is healthy and how it is managing risk in its own supply chain).

Develop business continuity plans.

Rather than making plans for every possible source of disruption, firms should instead make plans for the predictable capacity losses that result, independent of the nature of the disruption. By focusing on creating backup plans for the few possible outcomes, rather than preparing for every possible disaster, organizations can be better prepared for rapid recovery. This means developing a plan for continuity (a so-called business continuity plan) of the systems and processes that can break or fail. Developing such a plan is a very powerful method of vulnerability mitigation because it turns out there is a limited number of potential outcomes, at least in comparison with the hundreds and potentially thousands of different events that would translate into a supply chain disruption.

Reduce probability through prevention.

Companies should reduce the probability of disruptions by taking preventive measures. That entails developing a layered set of security measures to help reduce the chances of impact by having multiple necessary failures before a system failure is achieved. Some firms use pre-emptive action by taking greater control over their supply chains, integrating upstream suppliers when their supply is critical to their own operation.

Reduce consequences through resilience.

Companies should act to reduce the consequences of disruptions by investing in measures that will make the supply chain resilient. Resilience can be achieved through a balanced mix of redundancy (excess capacity or inventory) and flexibility (reconfigurable production systems and flexible workforces), where flexibility provides ongoing benefits to the organization and helps contribute to the development of a desirable resilient culture. There are many different ways to achieve flexibility: flexible supply contracts, flexible distribution systems, supply chain design, product design, and multi-skilled human resources.

Create a risk-enlightened culture.

Organizations should develop a plan to create a culture that supports supply chain risk management, including active risk monitoring, education, training, and simulation exercises. This long-term objective not only helps in preparation for disruptions but also enables effective response after a disruption.

Advance planning would have helped mitigate some of the supply chain disruptions that occurred in the wake of the Sendai earthquake and tsunami. Having backup supply arrangements, for instance, would have led to a rapid recovery for downstream customers of the locally affected companies. Having backup or distributed production options would obviously have been useful for those companies located in the affected area.

Hindsight is 20/20, and firms must make choices about how much contingency to choose. The decision is a function of several factors that are specific to the firm, but which are ultimately a tradeoff between the cost of the necessary investment and the potential risk of the disruption.

And sometimes businesses underestimate the risk. In response to the 2008 global financial crisis, for instance, companies would have been well served to have more aggressive controls on inventories, receivables, and payables that became critical when cash flow dried up. And in the preparation for the 2002 lockout of longshoremen by West Coast port operators, many firms had business continuity plans that called for five extra days of inventory; unfortunately, the lockout lasted 10 days.

The ongoing Sendai disaster represents a keen learning opportunity and another chance for firms that do not have comprehensive risk management plans in place. Disruptions to global supply chains are inevitable in frequency and impact, the only variables being location, source, and breadth of scale of impact.

The firms that weather disruptions best are those that have a comprehensive supply chain risk management approach, using a structured method for mapping the supply chain footprint, assessing vulnerabilities, and developing business continuity plans for the failure modes, risk monitoring and education, and simulation exercises. These firms develop a risk-enlightened culture that further helps the business deal with both unexpected disruptions as well as day-to-day variations in business operations. These cultures ultimately enable them to outperform their competitors and maintain a secure economic engine that serves their customers and supply chain.

Unfortunately, it is likely that many businesses will not learn from recent events, and instead will chalk up their immediate problems to the effects of a once-in-a-millennium event. And when the next global disruption occurs—and it will—those companies will claim that they are once again victims of forces no one could have predicted. ■