Chemical Companies: Minimizing the Risks of Supply Chain Disruptions

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Chemical companies face a growing array of risks. While some of these risks are specific to the chemical industry, many others are part of the more general risk landscape of companies operating in a rapidly changing, increasingly complex global business environment; an environment which is perpetually reshaped by factors such as technology, the economy, regulation, geopolitics, and changing cultural and social norms.

One issue of growing concern to chemical company risk managers is supply chain risk. “Complex” and “volatile” are words often used in describing chemical company supply chains, and with complexity and volatility come increased risk. One of the most worrisome risks for global supply chains is a sudden and severe break in the chain, which can be caused by a fire or explosion at a key supplier, a natural catastrophe, war, an economic downturn, or a number of other causes.

While not a new concern, the fragility of global supply chains was highlighted in 2011 when an unusually large number of severe natural catastrophes severed supply chains for companies across the globe. In particular, the Tohoku earthquake and tsunami which shut down a number of chemical plants, resulting in shortages of important chemicals that impacted not only the chemical industry, but also the plastics, semiconductor, automotive and other industries.

The tragic 9.0 magnitude earthquake and ensuing tsunami that struck northeastern Japan in March, 2011 destroyed infrastructure and knocked out factories that supplied everything from computer components to steel. Seven months later, Thailand, a country that manufactures about a quarter of the world’s hard-disk drives and is the Southeast Asian production hub for Japanese automotive companies, experienced the worst floods in 50 years, which shut down more than 14,000 businesses. Closer to home, Superstorm Sandy, in November 2012, shut down shipping terminals and submerged warehouses.

What may be a sound business decision for managing costs can also lead to complex new risk management challenges. A far-flung network of suppliers, especially in conjunction with “just in time” or “just enough” inventory strategies, can leave businesses vulnerable to disruptions in their supply chains. A natural disaster can affect the supply chains of thousands of companies, sending shockwaves throughout the global economy. Other sources of large-scale disruptions include war, political upheaval, labor disputes and economic downturns.

Terrorism is an increasingly significant risk. More rigorous inspections at border crossings after the 9/11 terrorist attacks created significant production delays for auto manufacturers depending on just-in-time component deliveries. Cyber terrorism is a growing concern as state-sponsored hacker networks become powerful enough to disrupt commerce in an entire nation or business sector. A recent attack on Persian Gulf oil companies was characterized by U.S. Defense Secretary Leon Panetta as a “significant escalation of the cyber threat” which has “renewed concerns about still more destructive scenarios that could unfold.”
It does not always require a national or regional catastrophe to disrupt global supply chains. A fire or explosion at a single important supplier can have disastrous consequences. A fatal explosion at the Evonik factory in western Germany, for example, affected half of worldwide supplies for CDT, a resin essential to auto parts manufacturers. From the perspective of any individual company, the loss of any hard-to-replace supplier is a mission-threatening event.

**Chemical company supply chains**

A supply chain encompasses all activities involved in sourcing and procurement, conversion, and logistics. Chemical company supply chains can range from being comparatively short and simple to enormously complex. Raw materials can sometimes be found in a manufacturer’s back yard, or they may need to be sourced from remote and dangerous regions of the world. The number of raw materials and suppliers can vary widely from company to company depending on the geographical diversity of operations and customers, the complexity of the product line, and the availability of raw materials. Materials may have to travel thousands of miles by road, rail, barge and ship to reach their destinations.

A report on supply chain issues of European chemical companies by Cefic and the European Petrochemical Association (EPCA) noted that changes in the pattern of trade have had the effect of lengthening supply lines and generally making the production and distribution of chemicals more transport-intensive. In another publication, EPCA observes:

> The current chemical supply chains are becoming longer, relatively more expensive and complex. Logistics are also becoming more important. Longer supply chains create challenges for managing safety, on-time delivery, flexibility, responsiveness and sustainability. Chemical producers may cut these longer supply chains up between many LSPs [logistics service providers] creating more complexity.

“Complexity is like a cancer that destroys supply chain efficiency,” according to a Pepsi supply chain executive quoted in *Supply Chain Digest*. Complexity also equates to greater risk – more moving parts means more can go wrong. According to a KPMG survey of global executives, “Increased risk stands out as the greatest challenge presented by complexity.” KPMG further notes that complexity adds “risk that were previously unthought of and unprepared for.”

In addition to – or more precisely, as a consequence of – greater complexity, global supply chains are subject to heightened volatility. Energy and raw materials costs are increasingly unstable, and demand can be uncertain. Geopolitical instability, a wavering economy, and terrorism inject further volatility into the system. Lean supply chain strategies reduce costs and impose rigor on the planning process, but if not carefully managed they can leave companies more exposed to volatility.

The Tohoku earthquake and tsunami highlighted vulnerabilities in chemical industry supply chains and the consequences for supply chains in other industries, especially plastics, semiconductors, electronics, and autos. Since 70 percent of Japanese chemical companies are small businesses with fewer than 50 employees, it is difficult to gauge the full impact of the crisis. Among the larger companies, comparatively few facilities were severely damaged by the earthquake and tsunami, but these events triggered automatic emergency shutdowns at many plants. This included plants owned by Mitsubishi Chemicals, Shin-Etsu Chemical, Mitsui Chemical Group, and Sumitomo Chemical. Return to full production was hampered by continuous aftershocks, tsunami alerts, evacuations, power outages and raw materials shortages. A few facilities were within the evacuation zone mandated by the government following the accident at the Fukushima Daiichi Nuclear Power Station.
In addition to chemical plants that were shut down by the earthquake and tsunami, some largely unscathed facilities had difficulty shipping their products because of a badly compromised transportation infrastructure. At the Mitsubishi Chemical Kashima Plant, for example, port infrastructure facilities damaged by the tsunami forced the company to suspend the supply of ethylene and other basic petrochemical materials.\textsuperscript{14}

Consequences of the earthquake and tsunami, and the subsequent power shortages, on chemical companies and their customers include:

- In the weeks following the quake, 23 percent of Japan’s ethylene capacity was shut. Benzine and xylenes production also was significantly impacted.\textsuperscript{15}
- All production of BT resin, which is used for substrates to package semiconductors, was suspended. Japan accounted for 70 percent of production of this resin.\textsuperscript{16}
- The sole source of Xirallic, an essential pigment used in car paint, was forced to temporarily shut down.\textsuperscript{17}
- Methyl ethyl ketone (MEK) prices around the world surged when the largest Japanese producer of the chemical was shut down because of the disaster. Japan produces approximately 15 percent of worldwide and 60 percent of Asian supply of the chemical used in ink and coatings.\textsuperscript{18}
- Caustic soda and chlorine shortages drove up prices in the United States.\textsuperscript{19}

Some chemicals were virtually unavailable on the world market for months.

One lesson learned from the Japanese disaster is that supply chain risk management focus needs to extend beyond direct suppliers to indirect suppliers. Some companies found that their suppliers were having their own supply problems because of the catastrophe, highlighting the need evaluate the exposures of key suppliers.\textsuperscript{20}

The previously mentioned explosion at the Evonik factory, which halved the world’s production of CDT, is another case study in supply chain vulnerabilities in the chemical industry. CDT is a key ingredient in a nylon resin called nylon 12, which in turn is a key component used in automotive fuel and brake lines.\textsuperscript{21} Evonik produced CDT for its own use in manufacturing nylon 12, but the company also was a supplier of the chemical to other manufacturers. BASF and Invista also make CDT, but they were unable to make up the shortfall.\textsuperscript{22} The shortage led to a scramble to find alternatives to nylon 12 for use in automotive parts.

A significant supply chain risk for chemical manufacturers is political and social instability. Raw materials often are sourced from dangerous and unstable parts of the world. For example, cobalt prices spiked 380 percent in the late 1970s as a consequence of a rebellion in Zaire, a country which produced half the world’s cobalt.\textsuperscript{23} In some cases, governments are in a position to essentially hold a critical material hostage. For instance, the price of palladium increased sharply in 2000 when Russia, the main source of this precious metal, hinted that it would withhold its supply from the market.\textsuperscript{24}

While there have been no successful, large scale attacks on chemical plants by terrorists, they are attractive targets. Many chemical companies are taking steps to reduce the impact of an attack on nearby populations, but companies also need to focus on the potential supply chain ramifications of an attack or a coordinated series of attacks on important facilities. Cyber terrorism is a growing, and ultimately perhaps the more significant, supply chain threat. Stuxnet – malware now understood to have been developed and deployed by U.S. and Israeli intelligence agencies to undermine the Iranian nuclear program – highlighted the threat of software that targets industrial control systems. Such software can be used for a variety of malicious purposes.
Supply chain risk management

Risk management experts have concluded that, while some companies have reasonably strong capabilities focused on a handful of key materials, the chemical industry overall needs to be better prepared for supply chain disruptions. Companies need to both reduce the frequency and severity of risks faced across the supply chain and to build resiliency into supply network design.25

“Supply chain agility” is a phrase that appears with increasing frequency in discussions about chemical company supply chains, and one with important implications for managing the risks of disruptions. Agile companies are prepared to react rapidly and effectively to unpredictable changes in supply or demand. Key to agility is identifying sources of variability and quantifying their negative impacts. Possible variability should be reduced or eliminated by changing supply chain design, processes, and business rules. For the remaining variability, a company needs plans and procedures in place to quickly respond to sudden changes.26 Scenario modeling and contingency planning need to be part of routine business processes and not an infrequent or one-off activity. Contingency planning should include key external stakeholders such as suppliers, logistics providers and customers.27

Supply chain risk management experts frequently recommend some variation of a traditional risk management framework to achieve these objectives. The elements of this framework are:

- Identify vulnerabilities,
- Identify the triggers for these vulnerabilities,
- Quantify the likelihood of occurrence and the potential impact,
- Prioritize risks,
- Define mitigation and risk transfer activities and evaluate their associated impacts and costs,
- Implement the risk mitigation/risk transfer action plan, and
- Steer, control and monitor the risk management process.28

To maximize supply chain resilience, companies should focus on low frequency/high severity events. “Avoid them if you can, but design your supply chains to cope if you can’t,” advised Prof. Dr. Behzad Samii, Eandis Chair in Resilient Supply Chains at Vlerick Leuven Gent Management School, speaking at the EPCA Interactive Supply Chain Workshop.29

Risk management consultants note that many companies do an excellent job of risk identification, but then fail to define and execute on a clear strategy for addressing those risks. Activities must be clearly defined and a constant reassessment process should be implemented. Some consultants recommend the creation of a risk management office dedicated to supply chain issues.30

Some of the specific steps chemical companies should evaluate for executing on their strategy include:

- **Diversify suppliers, preferably having suppliers located in different regions.** When equivalent materials are available from suppliers located in, for example, Europe and the Middle East, companies may be better off in the long run with suppliers in both regions, even if they have to accommodate slightly higher prices.
- **Identify alternative suppliers to fill gaps after an event.** The days following a disaster that shuts down major suppliers is generally a poor time to begin the process of identifying and establishing relationships with alternative suppliers. Procurement departments should know and have cultivated relationships with all the significant suppliers of key materials, and understand which suppliers represent the best alternative sources in the event of a crisis.
Chemical companies, which sometimes have supply chains spanning the globe, are exposed to a wide array of potentially disruptive events including war, political instability, natural catastrophes and terrorism.

- **Invest in suppliers.** By investing, companies can improve the stability of important but financially shaky suppliers, and more generally can exert greater control over decisions that can impact the likelihood of a disruption.

- **Focus on risk management criteria in the supplier selection process.** Among the criteria that should be evaluated in selecting a supplier are financial strength, compliance with regulations, risk management practices, and political stability and natural disasters in the supplier's country.

- **Require suppliers to adhere to good risk management and loss control practices.** Various contractual and incentive schemes can provide a practical means toward this end.

- **Substitute materials.** Chemical companies should evaluate alternative production methods that use materials that are less vulnerable to disruptions.

- **Blunt the financial consequences of a supply chain disruption by hedging risks and with specialized insurance products.** Contingent Business Interruption (CBI) and Logistics Extra Expense coverages are two insurance products that are valuable for offsetting certain financial losses resulting from supply chain disruptions. Recently a number of insurers have introduced "all risk" policies designed specifically for supply chain-related losses.

**Conclusion**

The concept of supply chain management is so ingrained into business thinking, it probably would surprise most people to know that the term itself first was used by consultants only in the 1980s, and did not come into wider usage until the 1990s. Managers previously focused principally on logistics. The broader concept of supply chain management, “the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities,” has emerged as a key strategic and operational concern largely during the past 15 years. Though a comparatively new discipline, the importance of supply chain management has increased exponentially as supply chains have grown longer and more complex.

With longer and more complex supply chains comes greater risk of disruptions. Chemical companies, which sometimes have supply chains spanning the globe, are exposed to a wide array of potentially disruptive events including war, political instability, natural catastrophes and terrorism. Some specialty chemicals are produced by only a handful of manufacturers – in some cases a single manufacturer – which means that something as simple and localized as a fire in a plant can cause disarray in supply chains throughout the world. The explosion at the Evonik factory in Germany, for example, nearly led to a crisis throughout the auto industry.

Frameworks for managing and mitigating the impacts of supply chain disruptions have been around for years, but many chemical companies have only recently begun to focus on building resiliency into their supply chains and developing the agility within their organizations to quickly respond to a disruption. Since supply chain complexity and volatility is likely to continue to increase, managing the risks of disruptions will become increasingly critical.
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