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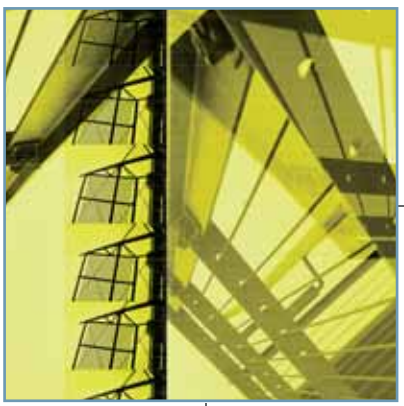

INDUSTRY ISSUES

by Rob Handfield

Reducing the impact of disruptions to the supply chain

A managerial framework based on observations from multiple executives

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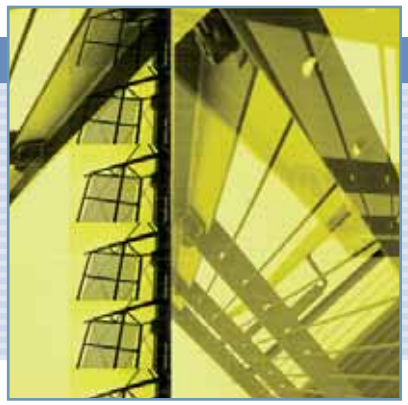

Reducing the impact of disruptions to the supply chain

A managerial framework based on observations from multiple executives

Low-cost sourcing has now become a staple of competitive strategy in many retail and manufacturing sectors. As organizations source a greater proportion of manufactured products from low-cost countries, they often do not consider the hidden perils of these approaches, especially within the context of enterprise risk management (ERM). Global sourcing affords many benefits in the form of lower price and expanded market access, but there are risks associated. Only recently have senior executives begun to recognize the increased risk attributed to the higher probability of product and service flow disruptions in global sourcing networks. A major disruption in the offshore supply chain can "shut down" a company, and have dire consequences on profitability. This was felt most drastically in the past few years, when such events as 9/11, the war in Iraq, the West Coast port workers strike, and increased regulatory and customs delays brought supply chain operations to a standstill. Other events that have an impact on customer service include natural disasters, fire and theft, poor communication of customer requirements, parts shortages, and quality problems. These disruptions can be costly and have in many cases brought distribution and production to a screeching halt. Supply chain disruptions can reduce shareholder value by as much as eight to 10 percent, or even worse in "time-sensitive" environments where early market introduction is critical to success.

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The topic of ERM is at the top of most corporate agendas, but the risk of extensive supply chain disruption as the consequence of an undesirable event is often overlooked. When organizations discuss ERM, the discussion often revolves around financial and strategic risk (see Figure 1). In reality, however, the total set of risks to an organization is much broader. It includes hazard risk and operational risk. Hazard risks refer to weather disasters, equipment shutdown, or product liability, while operational risks include major disruptions such as theft, late supplier deliveries, IT systems shutdowns and so on. As shown in Figure 1, a significant number of risk exposures have their root cause in entities located within their supply chain, which include all organizations and activities associated with the flow and transformation of goods from the raw materials stage

Figure 1: Enterprise Portfolio of Risks.

through to the end user, as well as the associated information flows.[1]

Supply chain management (SCM) is the integration and management of supply chain organizations and activities through cooperative relationships, effective business processes, and high levels of information sharing to create high-performing value systems that provide member organizations a sustainable competitive advantage.

As many organizations continue to outsource manufacturing to low-cost countries in Asia, the Caribbean, Eastern Europe, and Latin America, the increased frequency and severity of supply chain disruptions increases significantly. Research has shown that most organizations are not adequately prepared to manage supply chain risks. Recent studies suggest that only between five and 25 percent of FORTUNE 500® companies are prepared to handle crises or disruptions[2] and that a US$50 million to US$100 million cost impact can be incurred for each day a company's supply chain network is disrupted. Stock market reaction to supply chain disruptions have also been shown to be significant. Firms that have announced major supply chain problems have seen their shareholder value drop by 10.28 percent on average, with an average recovery time of 50 trading days.[3]

In high-tech markets, companies such as Sony have even pulled their manufacturing out of China and moved it to Japan.[4] Why? Sony executives found that the relatively unresponsive Chinese production lines could not adapt fast enough to cope with the unpredictability of market requirements for digital cameras.

However, avoiding risk is made more difficult by the increasing pressure to source globally, to exploit lower manufacturing costs and import products. The complexity of products and processes is also adding to the probability of disruptions. In this environment, what steps can an organization take to design its supply chains to assure uninterrupted material availability? Is it possible to respond in an agile manner to customer requirements in a global sourcing environment?

Based on a set of interviews with executives in multiple industries, we discovered several key themes associated with supply chain disruptions. First, companies should develop supply chain strategies that explicitly consider two parameters that "amplify" the negative impact of disruptions on customer and brand performance: globalization and product/process complexity. Second, companies should design strategies with countermeasures that mitigate the impact of these effects, namely:

- Improved visibility to key supply chain nodes that can quickly detect disruptions.
- Well-positioned resources that enable quick short-term recovery plans.
- Long-term collaborative approaches to eliminate disruptions in the future.

Our research also suggests that companies with a high exposure to global supply chain risk invest more in improved inventory and capacity visibility systems. Companies with complex products and processes are more likely to add incremental inventory and labor to buffer the impact of disruptions. Finally, organizations exposed to both types of risk also invest in longer term solutions such as training and collaborative tools to establish resilient supply chains that are agile and able to respond to disruptions. While no company can eliminate the probability of a major supply chain disruption, those that act appropriately ahead of time will be better positioned to manage these potentially devastating incidents when they occur.

How do supply chain risks occur?

Supply chain risk management systems comprise the set of systems and processes used to manage supply chain disruptions. Disruptions are defined as

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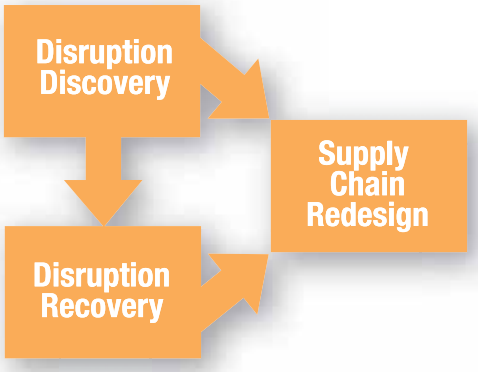
[1] *Handfield, R. and Nichols, E. (2002). Supply Chain Redesign, Upper Saddle River, NJ: Prentice Hall, 2002.*

[2] *Mitroff, I. and Alpasan, M. (2003), Preparing for Evil, Harvard Business Review, April 2003, 109-115.*

[3] *Hendricks, K. and Singhal, V. (2003). The Effect of Supply Chain Glitches on Shareholder Wealth. Journal of Operations Management, 21, pp 501-522. Knight, R. and Pretty, D., (1996). The Impact of Catastrophes on Shareholder Value. The Oxford Executive Research Briefings, Templeton College, University of Oxford, Oxford, England.*

[4] *Jiang, B., What Pulled Sony out of China? Supply Chain Management Review, Jan/Feb 2003, pp. 23-27.*

Supply Chain Triad



1. **Disruption Discovery**
   What type of intelligence does a firm need to detect disruptions?
2. **Disruption Recovery**
   Once the disruption is discovered, how does a firm effectively recover from a disruption?
3. **Supply Chain Redesign**
   How can a company strategically re-design its supply chain over time to become more resilient and avoid or easily mitigate disruptions?

Figure 2: Risk Management Framework.
Three key elements of supply chain disruption management.

major breakdowns in the production or distribution nodes that comprise a supply chain. These may include events such as a fire, a machine breakdown, an unexpected surge in capacity that creates a bottleneck, quality problems, natural disasters, customs delays, or any number of different problems. We first developed a common framework for discussing global supply chain disruptions, as shown in Figures 2 and 3.

Figure 2 illustrates the three critical components to a risk management program:

- The ability to discover that a disruption has occurred.
- The ability to recover from the disruption.
- Supply chain design strategies for resilience.

Figure 3 illustrates the impact of disruption to a firm over time. From the moment it occurs, a major supply chain disruption triggers a series of events that defines the relative maturity of a company's supply chain risk-management system. Let us consider an example from a recent disruption incident that illustrates the framework shown in Figure 3.

A major supplier to Nokia is Philips NV, which produces semiconductors for Nokia cell phones at its plant in Albuquerque, New Mexico. On March 17, 2000, a line of thunderstorms rolled through the city, and the furnace in the plant was hit by lightning and caught fire. The fire was extinguished in less than 10 minutes by the sprinkler system, but it had effectively destroyed the plant's clean room. (In a clean room, a small spec of soot can ruin the delicate microscopic circuits that are central to modern electronics.) Smoke had spread throughout the facility and had contaminated wafers in almost every stage of production, destroying chips for millions of cell phones in those few minutes.

Disruption discovery

As shown in Figures 2 and 3, after a disruption occurs, the speed at which the problem is discovered becomes critical. Executives must therefore understand the types of disruptions present in global supply chain systems and develop methods for discovering disruptions in a timely, responsive fashion. They must also develop an understanding of risk exposure and detect when risk events are about to occur, or have occurred.

At Nokia, the company's computer screens indicated that shipments of some Philips chips had been delayed. On March 20, 2000, Philips called Nokia's Chief Component Purchasing Manager, Tapio Markki, to explain the delay, which it said would be a week. The fire affected the production of some four million handsets. Nokia was about to roll out a new generation of cell phones that depended on the chips from the infirm Philips lab. More than five percent of the company's annual production might be disrupted during

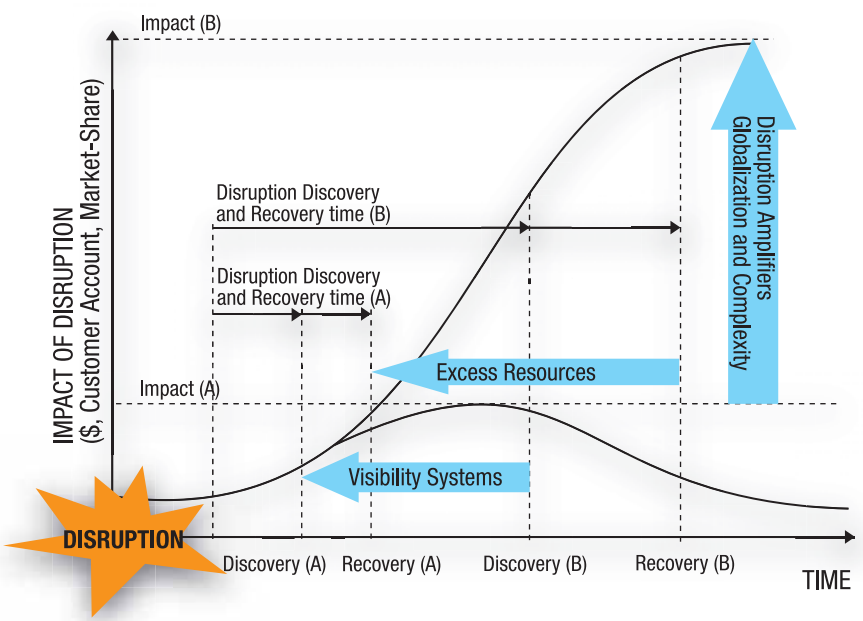


Figure 3: Disruption Discovery and Recovery.

The foundation for a solid supply chain risk management program includes improved knowledge of where the disruptions may occur, and training to know when and how to respond.

a time of booming cell phone sales. Although he did not see this as a major issue at first, Mr. Markki communicated the news to others inside Nokia, including Pertti Korhonen, Nokia's top troubleshooter. Mr. Korhonen decided that the situation needed closer scrutiny, and initiated a process of collaborating with Philips on recovery efforts. He suggested that two Nokia engineers fly to Albuquerque to help Philips. When they arrived, they realized it would take weeks to restore the cleanrooms and restart production.

Disruption recovery

Executives put in "stop gap" measures to recover from the disruption quickly, and prevent it from affecting their operations, or worse yet, their major customers. This element of management involves developing methods for supply chain disruption recovery both in proactive (anticipatory) and reactive modes.

Mr. Korhonen from Nokia quickly realized that the disrupted supplies would prevent the production of some four million handsets, and could impact five percent of their annual production. The team quickly ascertained the availability of alternative sources for the parts. They could purchase three of the five parts elsewhere. Japanese and American suppliers could each provide a million chips; their relationship with these suppliers led to agreements to ship with only five days' lead-time. However, two of the parts came from Philips only. Nokia's chairman spoke directly with Philips' CEO, Cor Boonstra, and demanded details about other Philips plants. The Nokia team dug into the capacity of all Philips factories and insisted on rerouting that capacity. Mr. Korhonen recalls that "The goal was simple: For a little period of time, Philips and Nokia would operate as one company regarding those components." The Finn's actions got results. A Philips factory in Eindhoven would provide 10 million chips, while another in Shanghai worked to free up more capacity to meet Nokia's needs. Nokia engineers developed new ways to boost production at the Albuquerque plant – creating an additional two million chips when the plant came back on line. Through these actions, Nokia was able to avoid disrupting *any* shipments to *its* customers.

Supply chain redesign

Once they recover from the disruption, executives learn from the event and take steps to redesign their supply chains to minimize the probability that the problem will occur again, or better yet, eliminate the possibility of it ever occurring again. This involves the development of tools for dynamic management of supply chain systems and redesigning/re-optimization of the supply chain.

Supply chain optimization cannot be a single static model. It requires tools that adjust with the dynamic nature of supply chain events. These tools should have global enterprise scope for enterprise redesign considerations and need to provide solutions in real time or near-real time. It should be noted that that for the most part, network optimization models currently in use are optimized for a "snapshot" in time and provide the optimal solution for the current operating and economic environment. What is needed is a set of tools that can track changes in the supply chain and work under a variety of operating and economic environments.

Nokia put in a series of dynamic visibility systems to track major shipments of all of its major suppliers. It also established a thorough risk management assessment for each of its major suppliers and created contingency fallback plans for disaster planning at each location. The company arranged supplier training in all of these planning elements. Finally, Nokia re-evaluated its entire supply chain network to avoid single-sourcing any major component and integrated these plans into its global sourcing strategies.

One of the major lessons to be learned from supply chain disruptions is that the speed of a company's response to a disaster is critical. As shown in Figure 3, the time between a disruption and its discovery is the first element – it is therefore important to put in systems to detect when a disruption occurs. The second element of response time is disruption recovery, and the lead-time from discovery to recovery. Companies that have already established contingency plans and visibility solutions, as well as excessive buffers such as inventory safety stock or extra capacity, will be able to recover more quickly and quickly mitigate the impact of these disruptions. In our Nokia-Philips example, other cell phone manufacturers that were sourcing from Philips, but did not respond quickly, experienced enormous negative impacts. For example, one of Nokia's competitors treated the initial call from Philips as "one technician talking to another," and allowed the one-week delay to take its course.

When it became clear that the much-needed chips were significantly delayed, lower-level employees at the company

still did not communicate the news to their bosses for fear of reprimand. The head of the consumer electronics division did not learn of the problem until several weeks after the fire. By the time the company realized the magnitude of the problem, it was too late. Nokia had already commandeered all of Philips' spare capacity. Moreover, the cell phone company did not have any alternative sources of supply.

The consequence was a shortage of millions of chips, meaning a shortage of millions of high-end handsets and the wrong product mix for the fast-moving cell phone market. This supply chain disruption contributed to massive losses for the company.

Supply chain disruption issues: Common themes

Our research surfaced three important and interrelated attributes that companies should consider in managing supply chain disruptions:

1. Supply chain knowledge

An effective system for disruption discovery and recovery requires a thorough understanding of the "as is" condition of the supply chain being examined, as well as the general status of external global, market, and environmental influences (e.g. political, cultural, etc.). This also includes knowledge of the organization's disruption plans and capabilities.

2. System-wide disruption awareness and capabilities

This includes real-time supply chain intelligence gathering, information sharing, and coordinated response. Risk and disruption handling cannot and should not be handled by a single department and/or one company. All players in the supply chain need to be involved in disruption planning and preparation. While disruption mitigation may be executed by a key logistics provider, all supply chain stakeholders need to be involved and regularly informed about disruption management activities. Certainly, disruption planning may be initiated and deployed by key companies in the supply chain with the resources to do so, but all of the key nodes in the supply chain need to be involved at some level.

3. Supply chain visibility

Supply chain visibility is defined as knowing how much inventory is available, where it is located in the chain, and the level of demand in the supply chain. This is probably the most important aspect of a successful system for dealing with disruptions. As one executive stated, "Visibility is the battleground relative to supply chain competitiveness." Unfortunately, there is no "silver bullet" that can handle all aspects of visibility. Visibility can only be enabled via a combination of technology and continuous communication.

Firms in the early stages of risk management should consider the following approach to assess and develop systems for managing supply chain risk:

- Develop a detailed and integrated value stream map on a pilot basis for a critical branch of global sourcing operations, highlighting not only material flow, but also information flow, inventory levels, decision points, mechanisms and triggers.
- Evaluate contingency plans on this pilot product for risk reduction effectiveness, and identify key thresholds for executing mitigation decisions.
- Establish a greater understanding of the external factors affecting the supply chain, through development of a node-by-node risk enumeration and identification plan, utilizing predictive risk analysis techniques.
- Establish additional insights into where and how much inventory is located throughout the supply chain, and how it can be accessed and repositioned rapidly during a supply chain disruption.
- Develop a detailed report documenting the factors that cause or amplify disruptions. Conduct "post mortems" of major past disruptions to identify contributing factors. This can help to surface weaknesses in current supply chain design, or product sourcing decisions that exacerbate supply chain risk exposure.

The foundation for a solid supply chain risk management program includes improved knowledge of where the disruptions may occur and training to know when and how to respond. The level of awareness of the potential for disruptions, and the capability to respond, is the single greatest preventive action that organizations can take to prevent the effects of a major disruption from disrupting global operations. Improved visibility of events is an on-going challenge, and there is a pressing need for companies to identify solution providers that can assist in supporting and developing these capabilities. ■

This article is based on a study first published at **http://scm.ncsu.edu/public/risk/risk7.html**

BIO

Rob Handfield

Rob Handfield, PhD, is a Bank of America University Distinguished Professor and Director, Supply Chain Resource Consortium, NC State University.

SAS Institute Inc. World Headquarters +1 919 677 8000
To contact your local SAS office, please visit: **www.sas.com/offices**

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