Combating Supply Chain Disruptions: Lessons Learned from Japan 2011
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A THINK Executive Report

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Introduction

The past decade has brought an ever-increasing number of natural and man-made disasters. To combat this uncertainty and minimize business disruptions, companies are putting strong business continuity management practices in place. However, even with the most rigorous strategy, it is a challenge to plan for low probability, high-risk events such as the recent earthquake, tsunami, and nuclear power plant leak disasters of Japan. Such events, termed as “Black Swans” by Taleb, professor at New York University’s Polytechnic Institute and author of a bestselling book on the subject, are typically unexpected and have a major impact on the economy and society. While Japan, as a nation that regularly encounters earthquakes, was prepared to some extent, planning for the magnitude of the damage that ensued from the March triple disaster was challenging to foresee.

In this report, we highlight some of the supply chain vulnerabilities particularly relevant to manufacturers in the innovative high-tech industry, using the recent Japanese disaster as an example, and what can be learnt from such events to combat future supply chain disruptions.

Understanding Japan

Today, relief operations and subsequent recovery efforts still continue on both the humanitarian and the business recovery front in Japan. The prefectures most affected by the disaster, Miyagi, Fukushima, and Iwate, are estimated to contain over 86,000 of the businesses in Japan that were affected, as well as US$209 billion in sales volume and 715 industries. ¹

Alongside the massive humanitarian impact, the natural disaster caused power outages, fuel shortages, closed factories, created radiation scares in products and containers, slowed or halted production and distribution through damage to rail and road networks, as well as disrupted the means by which staff travelled to work. Sea ports in the north of Japan were most affected by the earthquake and tsunami, resulting in shipping companies initially avoiding Japanese ports during their trans-Pacific routes.

Further, beyond the North-East region of Japan, Japan is an important part of the chain in global supply networks, particularly the electronics, cars and airplanes, energy and fuel, as well as logistics; industries in which the country has distinct advancements in technological precision, efficiency, and quality, and industries where Japan is viewed as being worldwide leaders.

Table 1. Global Dominance of Japanese SMEs: Key Components and Products

<table>
<thead>
<tr>
<th>Company</th>
<th>Key Product</th>
<th>Market Share</th>
<th>No. Of Employees</th>
<th>% of Overseas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toyo Tanso</td>
<td>Isotopic Graphite</td>
<td>World No. 1</td>
<td>2,000</td>
<td>56</td>
</tr>
<tr>
<td>Maruwa</td>
<td>Ceramics for Resistors &amp; IC</td>
<td>World No. 1</td>
<td>1,400</td>
<td>40</td>
</tr>
<tr>
<td>Fujimi</td>
<td>Silicon Wafer Polishers</td>
<td></td>
<td>259</td>
<td>N/A</td>
</tr>
<tr>
<td>Shima Seiki</td>
<td>Wefl Knitting Machinery</td>
<td>World No. 1</td>
<td>1,700</td>
<td>92</td>
</tr>
<tr>
<td>Wacom</td>
<td>Tablets in CAD Designs</td>
<td>World No. 1</td>
<td>730</td>
<td>78</td>
</tr>
<tr>
<td>Nihon Denta</td>
<td>Artificial Quartz Oscillators</td>
<td>World No. 2</td>
<td>4,800</td>
<td>68</td>
</tr>
<tr>
<td>Ushio</td>
<td>Industrial Halogen Lamps</td>
<td>World No. 1</td>
<td>5,000</td>
<td>70</td>
</tr>
<tr>
<td>Hamamatsu Photonics</td>
<td>Photo Electric Tubes</td>
<td>World No. 1</td>
<td>4,000</td>
<td>64</td>
</tr>
<tr>
<td>Murata Mfg.</td>
<td>Ceramic Capacitors</td>
<td>World No. 1</td>
<td>35,000</td>
<td>81</td>
</tr>
<tr>
<td>Nippon Chemi-Con</td>
<td>Aluminium Capacitors</td>
<td>World No. 1</td>
<td>7,500</td>
<td>75</td>
</tr>
<tr>
<td>F.C.C.</td>
<td>Motorcycle Clutches</td>
<td>World No. 1</td>
<td>5,500</td>
<td>76</td>
</tr>
<tr>
<td>Nagano Keiki</td>
<td>Mechanical Pressure Gauges</td>
<td>World No. 1</td>
<td>2,000</td>
<td>45</td>
</tr>
<tr>
<td>Tokyo Seimitsu</td>
<td>Circuit Board Probers</td>
<td>World No. 1</td>
<td>1,000</td>
<td>58</td>
</tr>
<tr>
<td>Hakkai Creates</td>
<td>Hinge for Mobile Phones</td>
<td></td>
<td>140</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Accounting for about 8 percent of global GDP, Japan is the world’s third largest economy.³ The triple disaster has affected economic variables including industrial production, disruptions to Japan’s electricity supply, consumer behavior, international trade, logistics operations and financial services,⁴ leaving uncovered many vulnerabilities in the supply chain that are traditionally left unaddressed and are not necessarily well understood.⁵

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³ Table 1 was adapted from Rajasekera J. 2011 (June). Japan Crisis: A Test to the Sensitivity of Global Supply Chains. Effective Executive June 2011. p 16.


Staying Agile and Lean While Mitigating Risk

Over the years, supply chains have been made increasingly lean in attempts to increase revenue, reduce cost, and minimize assets. In particular, the Japanese are well known for their Just-In-Time (JIT) manufacturing and supply chain practices that cut costs while improving product quality. 6

Another phenomenon in Japan is the Sōgō shōsha, a unique business entity and extent to which these small-to-medium enterprises (SMEs) play an important role in supplying parts to large enterprises via subcontracting. 7 Today, these SMEs are so specialized in Japan that they may be the only supplier available for a type of material, part, or technology, therefore creating a single supplier risk. While this specialization has played an integral role in establishing Japan’s automotive and electronics markets, these complexities make supply chains less able to cope with disruptions and have introduced vulnerability into the supply chain.

Furthermore, supply chains are increasingly complex, with several cross-border linkages resulting from global sourcing as companies reach to more distant suppliers for better pricing and unique supplies. 8 This complexity makes it increasingly challenging to assess and trace where different parts of a product originate. Figure 1 shows a snapshot of a generic company’s supply chain. Upstream in the supply chain, the company (focal company) has suppliers and sub-suppliers. Downstream in the supply chain, there may be wholesalers, retailers, and customers. Competitors (in grey) are also shown, as well as their immediate supply chain partners. To simplify the example, only two levels upstream and downstream in the supply chain are shown here.

Most companies concentrate on managing their immediate connections upstream and downstream in the supply chain (in bold black lines), and fail to consider or fully understand other inter-business process links that can impact their operations, such as their suppliers’ suppliers, as well as their competitors’ suppliers. However, examples of disruptions to the supply chain, such recent events in Japan, demonstrate the importance in understanding your full supply chain, as well as your competitors’, and building strong long-term relationships with suppliers and ensure access to sufficient supplies. This can also help manufacturers to gain complete visibility of their supply chain and better position them to mitigate risks that are often outside their control.

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More innovative products, as many of those produced in Japan, still require responsive supply chains to get products to the market faster. This however often results in an increase in cost. Functional products are more likely to be cost sensitive however, and a slower response time to deliver is generally more acceptable for these products. This relationship is represented in Figure 2, whereas response time decreases, costs increase, and vice versa.

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One of the key goals in operations management is to increase responsiveness of the supply chain or decrease costs, or both. As shown in Figure 2, if both these phenomena occur, the relationship curve will shift inward towards the axes of the graph, demonstrating improvement.

On the other hand, in the case of a supply chain disruption, there will be an increase in the chance for delays and hence, a likely increase in response time. In this case, we would expect the relationship curve to shift outward, where we expect that a longer response time may occur without a decrease in cost. Should goods still need to be moved faster than normal, the costs to expedite these shipments are likely to be substantially higher than normally allotted for. Companies such as DHL and UPS experienced such increases in their express courier services to and from Japan in the timeframe immediately after the disasters.

One question that arises from this scenario is whether companies should focus on controlling costs or improving responsiveness as part of their strategy to move out of the disaster state. This depends on the type of product or service that they are producing. As mentioned previously, more innovative products require responsive supply chains to get products to the market faster, often resulting in an increase in costs. As a trade off, a slower response time to deliver the goods is generally considered acceptable.

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Figure 2. Relationship between efficiency and responsiveness. Lower costs are often associated with longer response times. Short response times are associated with high costs.  

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Robust Supply Chain Strategies

Given these challenges and vulnerabilities, companies look for ways to strike a balance between cutting costs in daily supply chain operations, remaining agile and mitigating risks. Tang at UCLA identified a number of traditional supply chain management strategies that can be used to increase product and supply flexibility and availability, and increase control of product demand and of product exposure. However, while these are well-defined strategies, it is important to validate whether these supply chain strategies fit a firm’s business strategy before implementing them.

Possible supply chain risk mitigation strategies that can improve the efficiency, flexibility and responsiveness of your supply chain include:

1. **Postponement:** Delay the point of product differentiation by producing a generic product based on total product demand, then customize when necessary. This allows for a cost and time-effective way to reconfigure a product quickly should there be a supply disruption. Dell uses postponement, allowing for substitute configurations should certain parts not be available (see mini case study on page 8).

2. **Strategic stock:** While holding inventory could be considered unreasonably expensive, stocking in advance of demand by placing a shared inventory stock at certain strategic locations to be shared by multiple supply chain partners can reduce risk of supply loss due to warehouse damage.

3. **Rebalancing of the supply chain:** Have more than one supplier to be able to immediately switch to in the case of disruptions and maintain a flexible supply base. One of the most well known examples of the importance of having a flexible supply chain is where two companies supplier bases’ allowed them to react differently to a supplier’s plant disruption. In 2000, a Philips microchip plant had a fire that contaminated most of the plant’s stock of microchips. While Nokia, was able to work with Philips and their other suppliers to secure a stock of chips, as well as re-engineer some of their phones to fit other chips, Ericsson had single sourced the chips in an attempt to simplify their supply chain. This, paired with the assumption that the fire would have little long-term effects, meant that Ericsson lost a critical window of time to secure supplies, subsequently losing months of production. 12

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4. **Make-and-outsource:** Make some products in-house and outsource some production, allowing firms to shift production locations quickly if necessary.

5. **Networked economic supply incentives:** For products that have a very limited number of suppliers, the government may offer incentives to entice suppliers to enter the market, such as sharing some financial risks with new suppliers, or the industry itself may create incentives around establishing a network of suppliers. This has been particularly successful for Li & Fung, Hong Kong’s largest exporter and trader. This conglomerate relies on their global sourcing network to identify the best place to source raw materials from, and have created alliances among those in their global network of suppliers and manufacturers.

6. **Flexible modal choices:** Logistics companies are often hindered by pre-defined routes and trade lanes. However, having a flexible and diverse logistics strategy that relies on multiple modes of transportation, multiple carriers, and multiple routes will allow logistics companies and their customers to remain agile, should the routes need to be changed.

7. **Demand shaping and revenue management through dynamic pricing and promotion:** Use dynamic pricing to shape and manage demand. This is particularly useful when there is an excess of product (by using promotions to sell this product quickly) or when the supply of a particular product is disrupted (by pricing alternative products better to increase their sales and detract interest away from the original product).

8. **Psychological buying or time managed availability:** Changing the location of the product on a shelf, as well as the number of products on display, or having limited release of a product, can affect customer demand and product choice, and hence can be used to manage supply fluctuations.

9. **Silent product rollover:** In this case, there are products that can easily be substituted for the original, particularly with planned release strategies.

Tang has outlined how these strategies can be used to mitigate supply chain disruptions (see Table 1). For example, by having a flexible supplier base, a company can quickly shift where they obtain supplies from, should one supplier not be able to provide adequate supplies.
<table>
<thead>
<tr>
<th>Robust supply chain strategy</th>
<th>Main objective</th>
<th>Benefit(s) under normal circumstances</th>
<th>Benefit(s) after a major disruption: Enables a manufacturing firm to...</th>
<th>After a major disruption: Requires a logistics firm to...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Postponement</strong></td>
<td>Increases product flexibility</td>
<td>Improves capability to manage supply</td>
<td>...change the configurations of different products quickly</td>
<td>...be able to adapt services as product line changes.</td>
</tr>
<tr>
<td><strong>Strategic stock</strong></td>
<td>Increases product availability</td>
<td>Improves capability to manage supply</td>
<td>...respond to market demand quickly during a major disruption</td>
<td>...manage shared warehouses and distribution of stock among supply chain partners.</td>
</tr>
<tr>
<td><strong>Rebalancing the supply chain</strong></td>
<td>Increases supply flexibility</td>
<td>Improves capability to manage supply</td>
<td>...shift production among suppliers quickly</td>
<td>...quickly change routes to ensure adequate supply.</td>
</tr>
<tr>
<td><strong>Make-and-outsource</strong></td>
<td>Increases supply flexibility</td>
<td>Improves capability to manage supply</td>
<td>...shift production between in-house production facility and suppliers swiftly</td>
<td>...have strong connections with all supply chain partners, acting as a supply chain orchestrator.</td>
</tr>
<tr>
<td><strong>Network economic supply incentives</strong></td>
<td>Increases product availability</td>
<td>Improves capability to manage supply</td>
<td>...adjust order quantities rapidly</td>
<td>...be able to adapt services as product line changes.</td>
</tr>
<tr>
<td><strong>Flexible modal choices</strong></td>
<td>Increases flexibility in transportation</td>
<td>Improves capability to manage supply</td>
<td>...change the mode of transportation swiftly</td>
<td>...have end-to-end visibility of the supply chain to be able to make such rapid changes to transport used.</td>
</tr>
<tr>
<td><strong>Demand Shaping and Revenue management</strong></td>
<td>Increases control of product demand</td>
<td>Improves capabilities to manage demand</td>
<td>...influence the customer product selection</td>
<td>...be able to adapt services as product line changes.</td>
</tr>
<tr>
<td><strong>Psychological buying or time managed availability</strong></td>
<td>Increases control of product demand</td>
<td>Improves capabilities to manage demand</td>
<td>...influence the demands of different products fast</td>
<td>...be able to adapt services as product line changes.</td>
</tr>
<tr>
<td><strong>Silent product rollover</strong></td>
<td>Increases control of product exposure to customers</td>
<td>Improves capabilities to manage supply and demand</td>
<td>...manage the demands of different products quickly</td>
<td>...be able to adapt services as product line changes.</td>
</tr>
</tbody>
</table>

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13 Table 2 was adapted from Tang, C.S. 2006. Robust strategies for mitigating supply chain disruptions. *International Journal of Logistics: Research and Applications*. 9:1. pp. 33-45
Business Impact of Supply Chain Disruptions: A Closer Look at Japan

Since news reports have already exhaustively detailed the effects of the Japan crisis on various industries, here, we highlight and summarize these effects to-date.

**Electronics and Hi-tech Industries**

As one of the world’s high-tech centres, Japan plays a key role in delivering products with short product lifecycles, unpredictable demand, price erosion, and fierce competition.14 For example, Japan produces about 30 percent of the world’s flash

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memory and about 15 percent of the D-Ram memory used in PCs\textsuperscript{15}, laptop batteries and liquid crystal displays. Just last year, in addition to completed products, they exported 7.2 trillion yen (US$91.3 billion) of electronic parts.\textsuperscript{16}

Japanese electronics makers, including Panasonic, Sony and Toshiba, initially brought production to a halt after the natural disasters, stating that they were anticipating challenges obtaining raw materials and access to a continuous electricity supply for precision manufacturing, and that their manufacturing equipment may have encountered damage during the earthquake.\textsuperscript{17}

Data from the Japan Electronics and Information Technology Industries Association suggests that the recent Japan crisis events had only a slight effect on their electronics industry. Since 2005, each year has shown a spike in electronics production in Japan in March, followed by a substantial drop in production in April. While this annual trend was also observed this year, the increase between February and March’s production was not as substantial as in previous years, and was still followed by a substantial drop in production in April that could be attributed in part to the Japan disaster and in part to the annually occurring drop in production in April. Furthermore, recovery in May 2011 was slight, as in previous years, leaving this analysis inconclusive. Further analysis is still needed to include the later months of 2011 to reveal the extent of damage of the Japan crisis on the Japanese electronics industry.\textsuperscript{18}


\textsuperscript{17} BBC News Business. 2011 (March 18). Japan disaster: supply shortages “in three months.” BBC News.

Case Study on Initial Reactions to Supply Disruption: Mitsubishi Electric Corporation

Within hours of the March earthquake in Japan, fear of material shortages, power outages, and factory or logistics route damage raised alarms across the manufacturing world.

Mitsubishi Electric Corporation’s initial focus was on determining the impact of the crisis and maintaining clear communications throughout their business. It took them only ten days to fully assess the availability of supply for all components at thirteen of their Japanese factories, while offices maintained close daily communications with factories to provide accurate updates to customers.

When examining one of their factories, they found over 200 suppliers were located in the affected tsunami area; where it was unsafe to enter and businesses were encountering power blackout periods. To compensate for a decrease in production capability, the factories lowered their manufacturing capacity significantly to where at the end of May, they were running at 40 percent capacity, and only estimating to be back up to regular production by September 2011. The company was very conservative when accepting purchase orders at this time, initially only accepting ones where there were no penalties for extended delivery times. Maintaining production at this reduced rate would therefore allow them to have enough supplies to fulfill orders until as late as June or July.

Meanwhile, Mitsubishi Electric evaluated countermeasures that they could use to handle supply shortages. These included either sourcing from another supplier or changing product design. While they had previously identified alternative suppliers, testing of these suppliers still required a three month time period, and therefore, these supplies were only accessible as early as June. On the other hand, change to product design could possibly affect functionality or standards in different countries.

One of the biggest lessons learned from the Japan crisis, was the importance of knowing your suppliers’ sub-suppliers. While it only took Mitsubishi Electric ten days to complete their supply chain evaluation, having even more clarity in their supply chain could have allowed them to react even faster. Moreover, Japan’s reliance on specialized single-source suppliers has left Japanese technology industries open to vulnerabilities. Encouragement to develop alternative suppliers located in different locations could stimulate competition and could leave companies less susceptible to supply shortages.

Source: Mitsubishi Electric Corp. Interview with Yoshifumi Beppu, Managing Director and Chief Representative, Asia Pacific. May 31st, 2011.
Despite these inconclusive findings, reflections made in mid-2011 by Gartner market research firm suggest there was less damage to the global electronics and semiconductor industries than previously predicted. It has been suggested that the global electronics’ supply chains are particularly flexible and well understood by manufacturers.\(^{20}\)

Similarly, in a study conducted by eyefortransport, a U.S. based business research firm focused on logistics and supply chains, in March and April 2011, over half of high-tech and electronics companies surveyed expected only minor disruptions to their supply chain, suggesting that companies felt that they were prepared to handle such disasters.\(^{21}\) Eyefortransport speculated that companies believed alternative sourcing plans for necessary components were likely to be found before manufacturers ran out of existing supply stock. In contrast, only 2 percent of these companies felt that the disruption would be long-term and significant.\(^{22}\)

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Automotive and Automotive Parts Industry

The Japanese automotive industry is second only to China in terms of production numbers, and unrivaled in terms of quality. However, the recent March 11\textsuperscript{th} earthquake, tsunami and nuclear crisis shook and damaged automakers, automotive suppliers, sales and other auto-industry operations, and is likely to have had long-term impacts on the industry. Most vehicle production facilities suspended operations through the end of March due to damage to their facilities and the inability to secure an adequate electric power supply needed for their precision manufacturing. A drop in parts manufacturing in Japan contributed to parts shortages around the globe, and even non-Japanese car companies temporarily idled production in their plants abroad as they scrambled to trace and determine if their supply chain had parts coming from Japan, and to find out whether they were at risk for running out of parts and materials.

Moreover, damage to the nuclear power plant raised concerns and speculations over radiation levels of the vehicles and parts produced in Japan. However upon independent testing of radiation levels on vehicles produced in Japan, most Japanese automobile manufacturing facilities and ports showed radiation levels significantly lower than the maximum allowed by the International Atomic Energy Agency, and also showed to be safe for human health by the Nuclear Safety Commission of Japan.\textsuperscript{23}

The decline in Japanese automobile production can be observed in data collected by the Japanese Automobile Manufacturers’ Association (JAMA). There was a slight year-on-year decrease in automobile production in Japan, as suggested by the 6.3 percent year-on-year decrease between January 2010 and 2011, and the 5.5 percent year-on-year decrease between February 2010 and 2011. However, between March 2010 (945,220 units produced) and March 2011 (404,039 units produced) there was a 57.3 percent drop in production (see Table 2 and Figure 4).\textsuperscript{24} & 25 While production year-on-year dropped even further in April 2011 (down 60.1 percent from the year before), May showed less of a decrease, only down 30.9 percent, year-on-year. Further observation is required in later months to fully assess the impact of the disaster on the industry.


Combating Supply Chain Disruptions: Lessons Learned from Japan 2011

Table 3. Production of Motor Vehicles in Japan in January-May in 2010 and 2011

<table>
<thead>
<tr>
<th>Date</th>
<th>Passenger Cars</th>
<th>Trucks</th>
<th>Buses</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 2010</td>
<td>656,606</td>
<td>89,722</td>
<td>7,406</td>
<td>753,734</td>
</tr>
<tr>
<td>February 2010</td>
<td>732,477</td>
<td>100,014</td>
<td>9,278</td>
<td>841,769</td>
</tr>
<tr>
<td>March 2010</td>
<td>823,943</td>
<td>110,768</td>
<td>10,509</td>
<td>945,220</td>
</tr>
<tr>
<td>April 2010</td>
<td>627,320</td>
<td>94,884</td>
<td>9,625</td>
<td>731,829</td>
</tr>
<tr>
<td>May 2010</td>
<td>608,792</td>
<td>92,040</td>
<td>8,281</td>
<td>709,113</td>
</tr>
<tr>
<td>January 2011</td>
<td>609,598</td>
<td>87,830</td>
<td>8,679</td>
<td>706,107</td>
</tr>
<tr>
<td>February 2011</td>
<td>685,655</td>
<td>99,507</td>
<td>10,470</td>
<td>795,632</td>
</tr>
<tr>
<td>March 2011</td>
<td>348,474</td>
<td>50,852</td>
<td>4,713</td>
<td>404,039</td>
</tr>
<tr>
<td>April 2011</td>
<td>249,772</td>
<td>40,305</td>
<td>1,924</td>
<td>292,001</td>
</tr>
<tr>
<td>May 2011</td>
<td>410,971</td>
<td>74,804</td>
<td>3,948</td>
<td>489,723</td>
</tr>
</tbody>
</table>

It is also important to note that it was not just the Japanese automobile manufacturers that were affected by the events in Japan. German car company Opel and French car company Renault noted that they were affected by a disruption in certain electronics components being supplied from Japan. Also, America’s General Motors was affected due to a shortage in parts that were produced in Japan.²⁷

To gain a view on the global market, in March, ALG, a consultant and research firm for the automotive industry completed an analysis on the impact of the Japan earthquake on the automotive industry worldwide. They predicted that temporary disruption for the month of March is expected to mostly affect entry compact vehicles that are primarily produced in Japan. On the other hand, larger vehicles will be less impacted, likely because a part of their production often takes place outside of Japan.

Supporting this view, a large share of production for the large sedan, the Honda Accord, takes place in the U.S., and therefore an interruption in production could affect anywhere from 0.25% to 0.5% in pricing for a 20 day interruption, to 1 to 2 percent for a 100 day interruption. On the other hand, the small hybrid vehicle the Toyota Prius is exclusively manufactured in Japan. Therefore, while ALG estimates that a 20 day production interruption will only affect new transaction pricing by 1 to 2 percent, a 100 day production interruption could affect pricing of these smaller vehicles as much as 8 to 9 percent, assuming no change in demand.²⁸

While briefly halting production only slightly affected residual values and new market transaction prices, longer production interruptions are predicted to have a significantly larger impact. It was suggested that to compensate for inventory declines, plants outside of Japan could potentially increase production.

**Energy Industry**

Following the Japan disaster, Tokyo Electric Power imposed scheduled rolling power outages in efforts to prevent unforeseen blackouts. In addition to the significant impact on people’s daily lives, these power outages significantly affected manufacturing and other economic activities throughout April and May. Adding to the strain on the power grid, the explosions at Fukushima No. 1 plant, 250 kilometres northeast of Tokyo, have created further shortages in power.

Moreover, some of the key fuel infrastructure facilities in Japan have been damaged. With Japan producing 3-4 percent of the global jet fuel supply, the damage to their refinery capacities will potentially lead to fluctuations or increase in jet fuel prices. Coal stocks have also been lost in the flooding caused by the tsunami.

To minimize the impact of these shortages, the government implemented a full marketing campaign to promote energy conservation. In some regions, office air

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conditioner temperature settings have been increased by one degree Celsius in the summer. Many companies adopted a “No Overtime Policy” in August, and office building lights were turned out by 6 pm. Residents were also encouraged to go outside and to public areas during daytime hours to help reduce energy consumption at home. Companies such as Toyota also took a lead role in distributing power usage by changing work schedules so that power usage is evenly distributed throughout the week. As part of this plan, they had some staff in to work over the weekends and take time off during the week.

On the other hand, to ensure smooth running operations, a number of companies used backup generators to provide continuous power, and budgets and costs were less closely scrutinized during this time of disaster. Clients of Japanese companies also have been understanding in general, willing to work around the blackouts, and do not have unrealistic expectations on production, given the previous disaster state of the country.

**Logistics Industry**

The logistics industry has been directly affected by damage to routes by the earthquake and tsunami, the need to provide relief supplies and express shipments, and indirectly by a drop in manufacturing due to infrastructure damage, lack of access to supplies, and power outages.

The relatively flat levels of global trade in Q2 2011 can in part be attributed to the Japan natural disasters, and their effect on the Japanese economy and its trading partners. Logistics companies’ customers have seen their factory outputs declining, and have experienced supply chain disruptions and power outages, and a decline in exports and household spending.

Damage to Japanese ports mean the ports were avoided in shipping routes in the initial days after the disaster. Seaports of Tokyo, Yokohama and Nagoya resumed service on March 31st, while ports that were damaged by the tsunami, including Sendai port, took a bit longer to recover. Most of the airports in Japan were not affected long term, however as a major link in global air transport, there were initial concerns worldwide about whether the 6.5 percent of the world’s scheduled traffic that goes through Japan would be affected. Logistics companies have also taken mixed stances on safety measures to monitor for potential radioactive material contamination of goods in containers, as well as contamination of the containers themselves. Scanning containers and goods for radiation is not currently common practice for logistics companies, but could become so should radiation exposure become a recurring risk.

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On a positive note, the Baltic and International Maritime Council proposed that as the situation in Japan begins to return to normal, the demand for shipping may become higher in the medium term, perhaps to compensate for the drop in volume during the natural disaster.\textsuperscript{35} Also, in the short-term after the crisis, express shipping services were positively impacted when companies such as Dell increased their use of express logistics services to expedite short-term recovery of their business and maximize their supply accessibility.\textsuperscript{36}

With regard to humanitarian aid, logistics companies also played a large role in initial disaster relief efforts. Both UPS and DHL offered pro-bono domestic delivery of relief supplies to affected areas of Japan. As part of their CSR program, DHL donated over five tons of food and supplies by the 5\textsuperscript{th} of May and the UPS Foundation sent in large amounts of relief supplies in partnership with the Red Cross.

Perhaps most unique, logistics companies also acted as information brokers during the initial stages of the disaster, researching market information that was relevant to their clients, providing current information on what was happening on the ground in Japan, and translating and relaying government announcements through daily bulletins to those that they felt would be affected. Sharing this visibility with customers demonstrated logistics players’ advantages and capabilities to handle multiple situations, and reassured their customers that they were working with the right logistics players in the industry.

### Supply Chain Risks and Business Continuity Plans to Mitigate Them

From the 1970s to the 1990s, the number of natural disasters occurring worldwide has tripled. It is predicted that both natural and man-made disasters will increase five times in the next 50 years.\textsuperscript{37} In particular, Asia sits in a hotbed for disasters; from natural disasters such as floods in India and earthquakes in Japan, to political and economic issues such as riots in Thailand and the Asia Financial Crisis in 1997.

These disasters often affect a company’s supply chains, including their manufacturing operations. Supply chain initiatives to increase revenue (through increased variety and introduction of new products), reduce cost (JIT inventory practices and simplified supply bases), and reduce assets (through outsourced manufacturing), have helped improve firms’ financial performance, but also made global supply chains more complex, and hence, more vulnerable to disturbances.\textsuperscript{38}


\textsuperscript{36} Dell Inc. Interview with Piyush Bahrgava, Executive Director of Global Procurement and Ops Engineering. June 1\textsuperscript{st}, 2011.


Japan sits at the intersection of tectonic plates, termed the “Ring of Fire,” that circles the Pacific and is the most seismically unstable region in the world. Having this history of natural disasters, the Japanese are well prepared in response procedures and have building safety codes that ensure quake-resistant environments. Japan has also invested heavily in the development of technologies that detect earthquakes on the ocean floor, and have built seawalls in some coastal cities in anticipation of tsunamis. However, in March 2011, the magnitude of the earthquake and the height of the tsunami were unforeseen, leaving Japan underprepared for the damage and the resulting nuclear crisis in the aftermath of a devastating earthquake and tsunami.

Companies recognize the importance of risk assessment programs for their businesses however often lack the motivation to devote time and resources into managing supply chain risks and developing contingency plans. Possible reasons include:

- Firms cannot accurately assess risk to their supply chain, and hence underestimate the risk their business may encounter;
- Firms do not know how to manage supply chain risk;
- Given that many severe risks have a low probability of occurring, many firms find it difficult to perform a return on investment that justifies putting resources towards a risk reduction or contingency plan.\(^{39}\)

There is therefore a need to balance cost efficiency with adaptability, alignment and agility to motivate firms to take these precautions against these risks. This can be delivered through a robust strategy that minimizes costs and improves customer satisfaction under normal conditions, but that can also help sustain operations through the effects of a major disruption.\(^{40}\)

This strategy can then be conveyed in a detailed, well-reasoned business continuity plan that outlines risks and potential ways to mitigate them. While it is a challenge to estimate the probability of an occurrence of a disaster\(^{41}\), the effects of a supply chain disruption on a firm’s performance can be devastating, and hence, worth the investment in time and resources in developing a rigorous business continuity strategy.\(^{42}\)

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Types of Risk in Supply Chains

There are several potential risks that can arise and affect organizational infrastructure and business operations, including supply risk and demand risk, exchange rate risk and price rate risk, and disruption risks such as disease, natural disasters, and geopolitical risks. There is also the potential for one risk to lead to another risk. For example, the Japan natural disaster created a potential supply risk and an inability to meet demand. This was particularly relevant for Apple that launched the iPad2 on the same day as the Japan earthquake. Several of Apple’s suppliers are located in Japan, including those that source NAND flash and basic materials such as resins. Apple’s contingency plans and supplier partnerships put them at an advantage over smaller customers, however, the uncertainty and volatility surrounding the situation in Japan made it especially challenging to assess the long-term impact.

Supply Risk versus Demand Risk

Supply risk in a supply chain network is the possibility that an individual supplier is unable to meet demand at the required specifications. Demand risk, on the other hand, is the reduction in the predictability of demand, based on increased market disturbances. This demand volatility can be brought about by shorter life cycles of high-technology products, or higher levels of competitive activity, such as sales incentives and promotions. These sorts of risks can occur due to shortage of materials, loss of access to supplier, an inaccurate prediction of demand, and logistics or information technology failures.

“We are beyond the Henry Ford days, where all suppliers can be co-located. Today, we need to have a diversified supplier base and have more complex supply chains, despite this lowering the leveraging capabilities of each supplier. This however, requires more than one supply point to tap into.”

- From an interview with Paul Graham, CEO-Asia Pacific and Chairman of the DHL Supply Chain - Asia Pacific Management Board, June 1, 2011

Japan has a concentration of unique, single source suppliers producing high-value, sophisticated parts and materials. This specialization, coupled with a culture and desire to support local industry and concerns over moving manufacturing out of Japan due to potential for intellectual property theft, has dis-incentivized Japan to pursue a diversified supplier base. However, the magnitude of this recent supply chain disruption was a reminder to Japanese companies that given their high level of specialization and the country’s propensity for natural disasters, as part of their risk
Combating Supply Chain Disruptions: Lessons Learned from Japan 2011

management plan, it may be a crucial time to consider a move away from the concept of single suppliers. One option to stimulate this development is providing incentives for supplier diversification in other parts of Japan, or setting up other branches of their company in other countries.

Today’s supply chains are truly global, and rarely self-contained. Regardless of where manufacturing takes place, manufacturers still need to source components from abroad, taking advantage of lower labour and material costs around the world. This complexity of supply chains also increases the cost of supply chains, generally in terms of logistics, however also reduces the risk of suppliers being co-located in one area

Exchange Rate Risk and Price Rate Risk
Exchange rate risk refers to how changes in exchange rates can affect business operations or an investment’s value. This was particularly relevant during the recent global financial crisis, when the U.S. dollar greatly devalued, also affecting the exchange rate of other countries’ currencies.

DHL on having a Business Continuity Plan (BCP): Prepare for the Worst, Plan for the Best

DHL has always been ready with their own disaster relief process management plans in place to decrease adverse stakeholder impacts. Their personnel are well trained to manage the BCPs and related systems in the case of emergencies.

However, during the recent Japan natural disaster, DHL found that their employees in Japan had a particularly strong culture and readiness for responding to natural disasters. Within hours, employees were on the ground near the 30 kilometre disaster zone to assess what the situation was, determine which roads were functional, and how they could provide humanitarian aid.

Information technologies also made it easier to reach out to employees and customers to identify that they were safe within three hours of the earthquake. The IT infrastructure that DHL had in Japan quickly allowed them to ascertain the on the ground situation, and to keep employees and clients informed on the evolving situation.

Unexpectantly, the natural disaster actually improved parts of DHL’s business. There were increases in their express shipments where people urgently needed to get supplies that could not be moved by other means, or that were delayed, and replenishment goods needed to be moved quickly to disaster areas. Therefore, while in the initial four to six weeks, business was negatively affected, it appears that the subsequent erratic volumes and surges of activity that the region will go through to get back up to speed in subsequent months will only further contribute to business.

Source: DHL Supply Chain. Interview with Paul Graham, CEO-Asia Pacific and Chairman of the DHL Supply Chain – Asia Pacific Management Board, June 1, 2011.
**Disruption Risk**

The severity of damage from disruption risks is often unpredictable, and may involve natural disasters, geopolitical disruptions, and even terrorism. However, given today’s advanced capabilities of evaluating the likeliness of disruption risks occurring, it is possible to use generic strategic approaches to improve security and not jeopardize supply chain effectiveness. These strategies include: identifying sources of risk, determining the means by which such risks can take place, estimating the potential consequences, and providing approaches to mitigating and handling these consequences.

In recent years, we have seen a number of natural disasters in Asia, including the earthquake and tsunami of Japan, landslides and flooding in various parts of the region, and biohazard concerns such as SARS virus and H1N1 outbreaks, in 2003 and 2009 respectively. Terrorism risks include the effects of planned attacks, such as the September 11th, 2001 terrorist attacks in the U.S. and the July 2011 Mumbai bombings, on business operations and the need to understand how to operate under heightened security.

Lastly, geopolitical risks, including manpower related risks (such as increased labour costs or talent shortages), manmade attacks (such as regional political unrest), and import and export restrictions that are politically linked, can be a threat to organization’s operations on a regular basis.

**Classifying Japan’s Triple Disaster as a Black Swan**

As mentioned previously, Taleb coined Black Swans as low probability, high-risk events. With increasing global interconnectivity, complexity of networks, and speed of activities, today’s worldwide conditions are favourable for the occurrence of Black Swans.

This term is particularly fitting to describe the recent triple disaster in Japan. Despite Japan’s preparation and history of earthquakes, it was difficult to predict that such a severe triple disaster could occur with an earthquake larger than seismologists thought possible, leading to a tsunami that the sea walls could not contain, and followed by a nuclear power plant leak with an unprecedented impact.

Several indirect and unforeseen consequences also followed after the disaster, including a drop in the price of oil due to Japan’s sudden lack of demand, an increase in the price of electricity in Japan, resulting in higher production costs, as well as unstable currency exchange rates. There have also been speculations of the effects of the Japan crisis on the local political impact, the domestic economy, and global economics.

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Due to the unpredictable nature of Black Swans, preparing a business continuity plan to handle them can be extremely challenging. The best plan that most companies can venture to have includes conducting a business impact analysis and determining the minimum level of services and products that is acceptable to the organization to achieve its business objectives in the case of an emergency or a disaster. Moreover, building flexibility into the business will help the organization better respond when something actually does go wrong. While it is not possible to rely on past data to predict less-commonly occurring future events, it is beneficial to identify which critical paths could be affected by a disruption, assess and identify the worst-case scenarios on project and portfolio success, create a defined process of response, identify key decision makers that need to be involved, and know what are the critical functions of the business. These details are typically well defined in any business continuity plan.

**Business Continuity Plans: What companies need to be prepared**

Given the large number of potential supply chain risks, it is important to have strong business continuity plans in place that identify potential impacts that threaten an organization and outline how to build resilience and effectively respond and overcome disruptions.

*“Organize for action, not for recovery.”*

A Business Continuity Plan is meant to help make things happen. It should detail what tools senior management needs to be engaged, as well as how to proactively communicate with customers; essentially detailing how the company should “organize for action.” By understanding the potential stakeholder impacts, it is then possible to look at ways to minimize the disruption’s impact and duration.

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Business continuity management includes the following components:

These steps can easily be applied to understanding and mitigating the risks involved in the supply chain. For example, supplier risk can be assessed as follows:

Step 1. Know who your major suppliers are, particularly those who supply unique parts and services.
- Know what performance level you expect in terms of quality, schedule, and price.
- Perform a full Supplier Risk Assessment: How long will your supplier likely be in business? What is their financial strength? What is the quality of your relationship with them? What are the locations of suppliers, and their sub-suppliers, and the associated risks surrounding these locations?

Steps 2 to 4. Develop a business impact analysis and an action plan for each supplier: Know alternative suppliers that supply same materials, and understand how long it would take to change suppliers, and how much this change would affect costs.

Steps 5 and 6. Monitor Suppliers and Update Action Plan: What process is in place for monitoring suppliers? How often are these parameters checked for example, weekly) and how often is the plan updated (quarterly or yearly)? Who is responsible for monitoring?46

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Additional Ways to Reduce Supply Chain Disruptions and Their Impact

Despite rigorous business continuity planning exercises, the supply chain continues to be a shortcoming in business continuity management. The Just-in-Time delivery concept, while reducing lead-time and reducing risk exposure, is not able to withstand the high business volatility of today and its resulting disruptions to the supply chain. Moreover, the changing business landscape means that we cannot rely on historic data to predict the future.

It also does not help that supply chains are increasingly complex. This calls for increased visibility, using technology to facilitate this, as well as an open mind and willingness to consider a range of possibilities. The technique of Scenario Thinking can be used to evaluate potential future environments based on trends and general occurrences, and to better understand supply chain risks. Developed by Shell Group Planning in the 1970s, this is a structured process of thinking about the future that helps identify directions that would be most beneficial, regardless of what scenario might occur.

Though the possibilities are plentiful, three basic, yet key, tactics to mitigate supply chain risks that are relevant across companies and industries are:

Multiple Suppliers or Supplier Networks
As discussed previously, the most common approach to reducing supply chain risks remains having multiple suppliers for key parts of a manufacturing business. An alternative to this is having access to supply alliance networks where suppliers also form strategic alliances with other suppliers in different countries, and can leverage off of each other’s stocks and relationships.

The Use of Information Technology
Employees at all levels of the supply chain need to have access to information on inventory, storage and transport capacities in the supply chain to facilitate rapid planning and execution of supply chains. With an increasing trend for collaborative supply chain partnerships, having integrated supply networks can eliminate the need to try to interface individual networks, enables simultaneous planning of many components, and provides visibility and flexibility to the supply chain. This improved supply chain visibility can enhance coordination of operations, particularly

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automating the flow of information across organizational boundaries. However, while more companies are looking to technology to track and monitor risk, upfront costs can make it expensive to install, and requires trained parties on staff to monitor and advise others of its proper use.

**Staying Connected and Informed**

It is important to have a strong communications program in place to keep information flowing during all possible business scenarios. During disasters, a good communications program allows a company to efficiently work with employees to determine their safety and their families’ safety, and to communicate any plan details swiftly. During any supply chain disruptions, the mode of communication needs to be confirmed for accessibility and reach as conditions may differ from normal. For example, mobile telephones did not work in certain geographic areas after the Japan earthquake. However, the businesses that had satellite telephones available and the individuals that managed to use social networking tools to communicate their whereabouts were at a distinct advantage during the disaster.

**What can we learn from Humanitarian Logistics Practices?**

While in the past, those in humanitarian logistics looked to corporate logistics for best practices, today’s supply chains encounter highly unstable and volatile environments. As a result, the tables have been turned to where corporations can now learn from international humanitarian logistics organizations.

In humanitarian operations, there is a high degree of complexity in logistics and supply chain management due to the uncertain conditions of operations. The goal in humanitarian logistics is to save lives, often in highly unstable and volatile environments, under high time pressures, and in exhausting working conditions with poor infrastructure. There is often uncertainty and irregularity in demand, and hence, the need for flexibility in the supply chain. On the other hand, commercial logistics is typically characterized as running business as usual until they encounter an interruption where the business and its supply chain are put at risk.

Another contrast, in commercial logistics, global supply chains are often considered to hold more risk than domestic supply chains. However, in humanitarian logistics, it

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is the domestic part of the supply chain that often holds the most risk due to unstable environments such as damage from natural disasters and political riots.57

Table 4. Humanitarian Logistics versus Commercial Logistics

<table>
<thead>
<tr>
<th>Humanitarian Logistics</th>
<th>Commercial Logistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>High demand and supply source uncertainty</td>
<td>Demand uncertainty with known supply source</td>
</tr>
<tr>
<td>Unknown destination, time and type of supplies</td>
<td>Known destination, time and type of supplies</td>
</tr>
<tr>
<td>Multi-agent involvement</td>
<td>Multi-agent involvement</td>
</tr>
<tr>
<td>Unstable environment</td>
<td>Stable environment</td>
</tr>
<tr>
<td>Time pressure</td>
<td>Known deadline pressure</td>
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</table>

GOAL: Save lives                                           GOAL: Make profits

While some organizations have standard operating procedures in place to handle humanitarian disasters, these procedures often act more as informal guidelines, suggestions, and best practices, rather than stringent rules that must be followed.58 However, the similarities between supply chain risk management proactive planning used in humanitarian logistics, and in commercial business continuity management are uncanny, suggesting that risk mitigation between different environments need not be that different.59 & 60

The Supply Chain Planning Matrix, introduced by Fleischmann et al. (2005) outlines tasks of a typical supply chain. While generic in nature, it can be used in scenario planning exercises to perform business continuity planning and assess where issues might occur in a supply chain in the short, medium and long term, given a certain scenario or disruption, and also notes the material and information flows that are necessary to make decisions for planning in supply chain management.61

Rebuilding after disaster strikes

Japan, having gone through several earthquakes in the past, has shown remarkable resilience during and after a disaster. The country demonstrated just how prepared they were to handle a potential natural disaster. Roads were quickly cleared, reconstruction efforts swiftly embarked upon, and order was maintained in society, despite the natural disaster stimulating the potential for chaos. Moreover, Japanese companies were quick to establish crisis centres, find new suppliers, and adjust production to cope with temporary shortages. This organization can in part be attributed to the business continuity planning and execution experience of the Japanese companies, as well as the maturity and size of their market, quality standards, access to technology and excellent infrastructure, and the characteristic resilience of the population. How other countries might handle other disasters will depend on a variety of these factors and more.

One question that we discussed previously is whether companies should focus on controlling costs or improving responsiveness to move out of the disaster state. This likely depends on the type of product or service that is being produced. More innovative products require responsive supply chains to get products to the market.
The regional distribution centre warehouses of Kaigen Co., Ltd., a Japanese pharmaceutical and medical products company, were damaged in the recent Japan natural disaster. After evaluating the extensive infrastructure damage to their facilities, and the long term need of a stable regional distribution centre location to reach their expanding global markets, Kaigen decided to move their regional warehouses to another location in Asia.

Kaigen’s partnership with UPS helped them to decide to relocate their warehouses to Singapore. As more and more companies choose to establish their regional distribution centres in Singapore, the country is gaining a reputation as an ideal central location for companies to base their regional distribution centres to leverage on Singapore’s multi-modal connectivity, excellent infrastructure, and government incentives for industry. Via Singapore, healthcare companies such as Kaigen have easy access to distributors, hospitals, and clinics in major Asian cities, and can reach more than three billion people in the fastest growing region for the healthcare industry in the world. Moreover, Singapore has specialized capabilities in place that can support the biomedical sciences industry, such as cold chain management technology, full information visibility and quality control, and awareness of regulation requirements for markets in the region; therefore offering an integrated supply chain management solution.

Having a strong understanding of Singapore’s laws and regulations and licenses that need to be obtained, the right relationships here in the region to facilitate the centre’s setup, and the ease of Singapore practices involved in establishing a regional distribution centre, UPS was able to leverage their capabilities and connections to facilitate the setup of Kaigen’s warehouses in Singapore within the short time of three months; setting an example for other companies considering moving their regional distribution centres to Singapore and demonstrating a clear economic opportunity for Singapore.

Source: United Parcel Service (UPS) Singapore Pte Ltd. Interview with James Goh, Vice President of International Trade Services, Asia Pacific, June 28, 2011.

faster, often resulting in an increase in costs. On the other hand, functional products are more likely to be more economical. As a trade off, a slower response time to deliver the goods is generally acceptable.

As operations return to normal after business disruption, it is important to note that “normal” operations may not be the same as the pre-crisis state, at least in terms of people operating in the same everyday fashion. For example, while Japan is currently a major supply point, this may shift in the future, or at a minimum, suppliers may be diversified within the country. Japan is already far less connected to the global economy than many other developed countries. A lot of manufacturing has already been moved to China. As a result, while manufacturing was affected, the supply chain crisis that could have occurred, including lengthy plant shutdowns worldwide, did not happen. Ideally, Japan and other countries struck by disaster will be able to learn from these unfortunate events, and will adapt their practices, policies and regulations, relationships and infrastructure in attempts to be better prepared the next time disaster might strike.
Conclusions and Lessons Learned

Throughout this report, we have explored ways in which manufacturers, supply chain managers and logistics service providers can handle supply chain disruptions, drawing from the examples taken from the recent Japan triple events. The key takeaways for manufacturers to be prepared for supply chain disruptions include:

1. **Build scenarios and evaluate them for risks:** Conduct scenario planning exercises to assess where issues might occur in a supply chain in the short, medium and long term, given a certain scenario or disruption. Note the material and information flows that are necessary to make decisions for planning in supply chain management.

2. **Have a Business Continuity Management Team:** Have a dedicated risk management function or team in place that is connected to all aspects of the business. This visibility will allow them to assess potential risks and understand potential stakeholder impacts.

3. **Move away from single suppliers and create supply chain networks:** The magnitude of this recent supply chain disruption was a reminder to Japanese companies that given their high level of specialization and the country’s propensity for natural disasters, as part of their risk management plan, it may be a crucial time to consider a move away from the concept of single suppliers. One option to stimulate this development is providing incentives for supplier diversification in other parts of Japan, or setting up other branches of their company in other countries.

   Furthermore, today’s supply chains are truly global, and rarely self-contained. Regardless of where manufacturing takes place, we still need to source components from abroad, accessing rare materials and taking advantage of lower labour and material costs around the world. This complexity of supply chains can potentially increase the cost of logistics operations, and requires additional effort to maintain end-to-end visibility, however also reduces the risk of suppliers being co-located in one area.

4. **Know the scope of your supply chain:** More innovative products, as many of those produced in Japan, still require responsive supply chains to get products to the market faster. This however often results in an increase in costs. Functional products are more likely to be more cost sensitive however, and a slower response time to deliver is generally more acceptable. Understanding your product and its market will help determine whether responsiveness or efficiency is more important to get your business running normally again.

5. **Having a strong business continuity plan in place:** Given the large number of potential supply chain risks, it is important to have strong business continuity plans in place that identify potential impacts that threaten an organization, and outline how to build resilience and effectively respond and overcome
disruptions. The BCP should detail what resources senior management needs to be engaged, as well as how to proactively communicate with customers; essentially detailing how the company should “organize for action.” By understanding the potential stakeholder impacts, it is then possible to look at ways to minimize the disruption’s impact on stakeholders and the duration of the impact.

6. **Have a learning system in place:** After a supply chain disruption, it is important to conduct a final review to assess how a supply disruption was handled, what was done well and what could be improved upon. Furthermore, disruptions that affected other countries and other parts of the world should be regularly reviewed and evaluated to assess how they were handled and which tactics, that were used in that unfortunate event, could be applied to further secure your own supply chain.

We hope that through this report, companies can benefit from the lessons learnt and be watchful and better prepared for the next disruption in the supply chain.
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