WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Industry Agenda

New Models for Addressing Supply Chain and Transport Risk

An Initiative of the Risk Response Network
In collaboration with Accenture

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Organizations, industry and government can improve their understanding of global supply chain and transport risks and proactively move towards a new 21st century model for collaborative risk management

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To effectively manage supply chain and transport risk, greater collaborative effort is needed on:

- *Development of trusted networks between government and business*
- *Risk quantification*
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Executive Summary

Global supply chains and transport networks form the backbone of the global economy, fuelling trade, consumption and economic growth. Trends such as globalization, lean processes and the geographical concentration of production have made supply chain networks more efficient, but have also changed their risk profile. Most enterprises have risk management protocols that can address localized disruptions. However, recent high-profile events have highlighted how risks outside the control of individual organizations can have cascading and unintended consequences that cannot be mitigated by one organization alone.

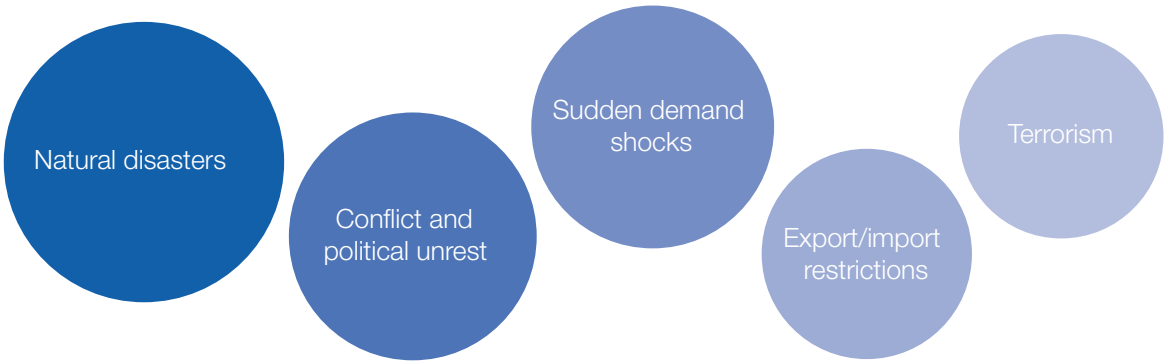
Supply chain and transport disruptions are no longer seen as the purview only of operational risk managers. Changes to governance models in the wake of the 2008 global financial crisis and other major disruptions have pushed organizations to review their own approaches to identifying and mitigating systemic risks. C-suite level leadership and corporate boards are increasingly understanding and being held accountable for the many aspects of organizational risk.

Governments also have been increasingly challenged to understand and manage risk across global supply chain and transport networks. The political, economic and security implications of regulating in a complex environment have necessitated new approaches for public-private collaboration.

Following discussions during the Annual Meeting in Davos-Klosters in 2011, the Forum engaged a diverse group of supply chain and transport risk experts to explore systemic vulnerabilities. This supply chain and transport risk report reviews external shocks, network trends and vulnerabilities. It proposes risk mitigation approaches to further develop and suggest recommendations for action.

Understanding Supply Chain and Transport Risk Exposure

Top external disruptors



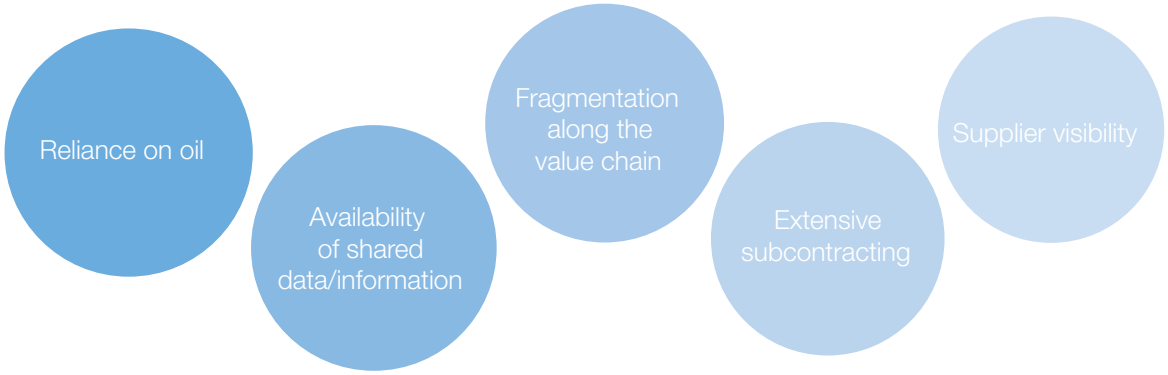
Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

Systemic risks within supply chain and transport networks are characterized by an unexpected trigger event and a network setup that cannot absorb the shock and knock-on effects. The initial event results in a cascading disruption or failure across regions or industries.

However, prediction of specific disruptions is felt to be less important than having the resiliency in place for effective response, no matter what the cause. While highlighting industry robustness in the face of recent shocks, experts identified the vulnerabilities of most concern that limit the resilience of supply chain and transport networks.

Note: The World Economic Forum report Global Risks 2012, Seventh Edition, provides public and private sector leadership with an independent platform to better map, monitor, manage and mitigate global risks. The report describes 50 global risks and groups them into economic, environmental, societal, geopolitical and technological categories. Find the full details at www.weforum.org/global-risks2012

Top network vulnerabilities



Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

Implementing Improved Systemic Risk Management

The expert group[1] assessed the difference between the risk management methods available today and those most important in the future to identify risk management methods most in need of development.

Top management priorities

Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

Recommendations for Government and Business

1. Improve international and interagency compatibility of resilience standards and programmes
2. More explicitly assess supply chain and transport risks as part of procurement, management and governance processes
3. Develop trusted networks of suppliers, customers, competitors and government focused on risk management
4. Improve network risk visibility, through two-way information sharing and collaborative development of standardized risk assessment and quantification tools
5. Improve pre- and post-event communication on systemic disruptions and balance security and facilitation to bring a more balanced public and private sector discussion

[1] In this report, unless otherwise noted, "expert group" refers to contributors who are acknowledged at the end of this report.

Understanding Global Supply Chain and Transport Risk

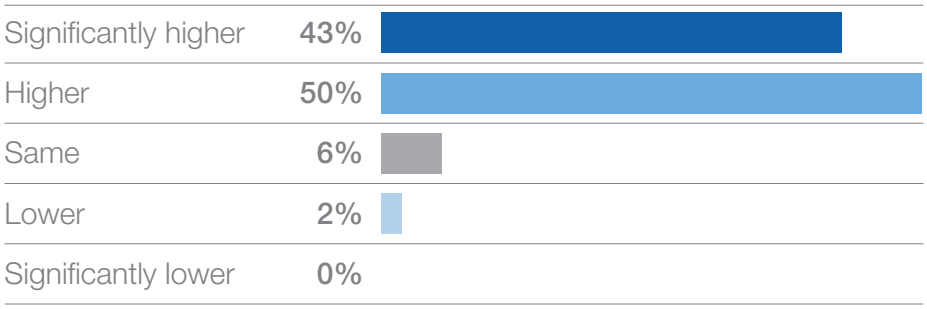
Increasingly globalized operating models and the growing interconnectivity of supply chain and transport networks are leading to evolving risk profiles and new systemic risk management priorities

Increasingly globalized operating models and the growing interconnectivity of supply chain and transport networks are leading to evolving risk profiles and new systemic risk management priorities

Risk profiles are changing as businesses' operating models become more globalized, and supply chain and transport networks become increasingly complex, interconnected and interdependent. Major disruptions in the last five years – including the global financial crisis, terrorist scares, flooding in Thailand and the Japanese earthquake and tsunami – have heightened public discussion on risk preparedness within supply chains and transport networks.

More than 90% of those surveyed by the World Economic Forum indicate that supply chain and transport risk management has become a greater priority in their organization over the last five years (Figure 1).[2] At the World Economic Forum Annual Meeting 2011 in Davos-Klosters, CEOs from the Automotive, Aviation and Logistics communities agreed on the need for better awareness and management of global risks across industries increasingly characterized by complexity and interdependencies, and the requirement for new models of supply chain and transport risk management.

Figure 1: Changing priorities of supply chain and transport risk management



Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

Most major organizations have some form of enterprise risk management approach that addresses local and internal operational risks. In a 2011 survey by Accenture of almost 400 executives across 10 major industries, more than 80% of survey respondents had an enterprise risk management programme in place, or plan to implement one within the next two years.[3]

However, the interconnected nature of global supply chain and transport networks means modern businesses are often "reliant on thousands of independent suppliers and partners located in many countries". [4] Consequently, they both affect and are affected by risks at various stages, from the sourcing of raw materials to the destinations of goods and services, and these risks are not always within the confines of the company's control.

This report focuses on **systemic supply chain and transport risk – outside the direct control of one individual organization and with global implications**. The key entities impacted include:

- Manufacturers and vendors
- Logistics operators, transport providers and transportation/production/consumption hubs
- Retailers
- Consumers and passengers
- General public
- Government and regulatory bodies

For each of these entities, the organizational appetite or tolerance for risk must be balanced against risk exposure, often requiring risk management functions to prioritize competing business demands. The recent financial crisis has added to the challenges of risk management, encouraging the implementation of short-term cost saving strategies, such as single sourcing of critical resources, with longer-term implications to risk profiles.

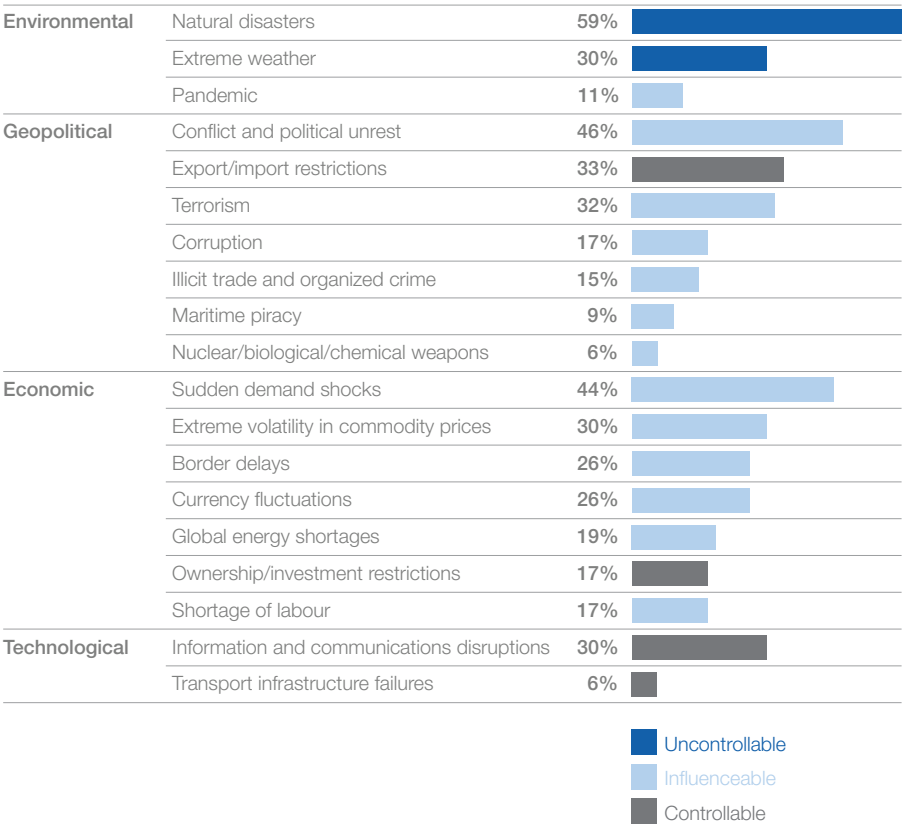
As supply chain and transport networks evolve in a dynamic environment, there is an urgent need to review risk management practices to support both long- and short-term strategic decision-making. The risk exposure of organizations must be carefully analysed against objective and transparent criteria, and costs must be weighed against the benefits of potential risk mitigation methods.

[2] World Economic Forum Supply Chain and Transport Risk Survey 2011 (Appendix 2)
[3] "Report on the Accenture 2011 Global Risk Management Study", Accenture (2011), p.17
[4] "Logistics and Supply Chain Industry Agenda Council", World Economic Forum (2011), p. 9

Certain external events can cause widespread, systemic disruptions to supply chain and transport networks

Local disruptions to supply chain and transport networks occur on a daily basis. However, certain external events, when combined with existing network vulnerabilities, have the potential to cause widespread, systemic disruptions. Survey respondents ranked the exogenous disruptions most likely to provoke significant and systemic effects on supply chain or transport networks (Figure 2).[5]

Figure 2: Triggers of global supply chain disruptions



Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

Disruptions are categorized according to four risk categories: environmental, geopolitical, economic and technological.[6] The first three categories ranked highest.

Environmental Risks

Given high-profile events such as the Eyjafjallajökull volcano eruptions in 2010, the 2011 earthquake and tsunami in Japan and the 2011 floods in Thailand, an unsurprising 60% of experts surveyed indicated that natural disasters are mostly likely to cause systemic supply chain or transport disruptions.[7] Weather, a related risk, is also ranked highly, with 27% of respondents identifying it as a key concern. Similarly, the 2011 Global Risks Perception survey identified environmental risks such as meteorological and hydrological catastrophes as two of the most likely risks to occur.[8]

According to a Swiss Re study, worldwide economic losses from natural disasters in 2010 totalled US$ 194 billion.[9] Such disasters can damage infrastructure, interrupt production and significantly impact private sector financial performance: an analysis of 15 publicly listed multinational companies indicated that operating profits fell by up to 33% in the financial quarter following the 2011 earthquake and tsunami in Japan as a result of supply chain disruptions.[10] The public sector can also face significant costs, with the Japanese government allocating a ¥ 12.1 trillion (US$ 239.3 billion) budget for the reconstruction of areas devastated by the 2011 earthquake and tsunami.[11]

As natural disasters are hard to predict or prevent, the focus must be on making the right investments before the event to reduce supply chain and transport network system vulnerability and improve recovery capability.

[5] World Economic Forum Supply Chain and Transport Risk Survey 2011
[6] The World Economic Forum report Global Risks 2011 includes a fifth category on societal risk; however, it is not referenced in this report as it was not identified as a key disruption trigger by the expert group
[7] World Economic Forum Supply Chain and Transport Risk Survey 2011
[8] "World Economic Forum report Global Risks 2011, World Economic Forum, January 2011
[9] "Natural catastrophes and man-made disasters in 2010", Sigma No1/2011, Swiss Re (February 2011), p. 4
[10] World Economic Forum and Accenture financial performance analysis, based on companies publicly reporting supply chain and transport disruptions as a result of the Japanese earthquake
[11] "Japan's reconstruction budget to boost GDP by 1.7%", www.reuters.com, 28 October 2011

Geopolitical Risks

Geopolitical disruptions encompass a range of potential disruptions including conflict and unrest, terrorism, organized crime and corruption. The on-going concern about the effects of terrorism on global supply chains is illustrated by the cumulative increase in expenditure of over US$ 1 trillion in US domestic homeland security since 9/11, as well as a range of new industry regulations and requirements across supply chain and transport networks.[12]

While businesses are concerned that a security disruption may affect a critical production or distribution hub, they also worry that fear of such events can trigger legislation that could have an equally disruptive effect. The expert group pointed out that new security requirements following 9/11 to build enhanced protection, while well-meaning, have failed to strike the right balance between protecting against terrorist threats and facilitating the smooth flow of goods and people.

Conflict and political unrest were identified as a key concern by 46% of respondents. Persistent military conflict can cause disruption to major transport routes or production hubs; according to the International Energy Agency, escalating violence in Libya in March 2011 meant that up to two-thirds of Libya's oil production would not make it to market.[13] Areas where terrorism or limited law enforcement is prevalent – whether in trade routes such as the Malacca Straits, or countries such as Indonesia – pose risks to employees and goods within the supply chain.

Maritime piracy is an increasing concern for supply chain professionals and transport providers, and is estimated to be costing the international economy between US$ 7 billion and US$ 12 billion per year.[14] The International Maritime Bureau reported a 36% increase in the number of attacks in the first half of 2011, and noted an increasingly organized and sophisticated approach.[15] While the threat has tended to be regionalized, union strike action as a result of threats to employee security is a growing possibility, and shipping companies are increasingly accepting the additional costs of rerouting via much longer distances.

Illicit trade, organized crime and corruption are highlighted in the Global Risks 2011 illegal economy nexus, due to their "influence on three other important global risks – fragile states, terrorism and geopolitical conflict – which, in turn, have a significant and negative impact on global stability".[16] Illicit trade is now thought to represent between 7% and 10% of the global economy, and rough estimations by the Forum's Global Agenda Council in 2009 put the market size at US$ 1.3 trillion.[17] Shadow supply chains, counterfeit products and IP infringement can have an extensive impact across supply chain networks. For example, in 2010, VisionTech was found guilty of selling counterfeit military and commercial-grade integrated circuits to the US Navy, defence contractors and other industries – for use in mission-critical military and medical systems to consumer goods.[18] The size and global spread of illicit trade networks compounds the challenges for industry, while undermining economic development by raising the cost of doing legitimate business.

Geopolitical disruptions are hard to manage in the short term, with limited opportunities for industries to influence outcomes. It necessitates a dual approach of both risk reduction and increased network resiliency.

Economic Risks

Economic disruptions cover a range of issues, including currency fluctuations, commodity price volatility, sudden demand shocks, border delays and ownership/investment restrictions – many of which have been highlighted by the global financial crisis in 2008 and the current Eurozone crisis. Following the 2008 financial crisis, annual filings for supplier bankruptcy within the automotive sector roughly doubled from 2007 to 2008.[19]

Currency exchange rate fluctuations in 2010 dealt a financial blow to many businesses. The trend towards globalized supply chains to lower costs and improve profitability has resulted in organizations with a substantial proportion of operations overseas. Systemic disruptions driven by currency fluctuations are more likely when sourcing or access is concentrated. The economic viability of certain supply and transport chains is dependent on a critical mass of traffic. When major flows dry up, this has a cascading effect on other flows, sometimes not obviously connected – for example, through passenger and belly-cargo interdependence.

External shocks can result in sudden changes in demand across an industry or sector, with 44% of respondents identifying this as a key concern. Following the 9/11 terrorist attacks, the fear of another terrorist attack and the increased security hassle at airports saw a decline in US passenger travel by 5.9% in 2001.[20] A sudden demand change as a result of a global shock was also highlighted by the E. coli outbreak in Europe, when health warnings led to a decline in cucumber sales in Germany by 70%.[21] Nine countries took measures to block or restrict salad vegetable imports, costing producers in Spain an estimated 200 million euros per week as orders were cancelled and trucks laden with unwanted goods were turned away.[22]

Export/import restrictions and border-crossing delays are a daily reality. Despite significant growth in international trade, cross-border movements remain vulnerable to customs regimes, tariff and non-tariff barriers, quota systems, security concerns and infrastructure bottlenecks. A study by the World Bank in 2004 concluded that enhanced capacity in global trade facilitation would increase world trade of manufacturing goods by approximately US$ 377 billion, an increase of about 9.7% in global trade.[23] However, from a risk perspective, the greatest concern is the possibility of sudden new restrictions or delays, highlighting the need for mature risk management in national border administrations. The stalling of the Doha round of trade negotiations has heightened fears that recent openness gains could be lost.[24]

The Global Risks 2012 report identifies major systemic financial failure, chronic fiscal imbalances and extreme volatility in energy and agricultural prices as three of the top five global risks having greatest impact if they were to occur.[25] This further supports the general conclusion that economic disruptions are top of mind for risk experts across many domains.

[12] Mueller, J. and Stewart, G. "Balancing the risks, benefits and costs of homeland security", Homeland Security Affairs, March 2011, p. 1

[13] "Analysts say Libya crisis can push oil prices past US$ 200", Centre for Global Energy Studies, www.cges.co.uk, March 2011

[14] "The Economic Cost of Maritime Piracy", One Earth Future Working Paper (December 2010), p. 2

[15] Maritime Bureau's (IMB) Piracy Reporting Centre

[16] World Economic Forum report Global Risks 2012, World Economic Forum, Jan 2012

[17] Ibid.

[18] "Counterfeit Integrated Circuits Indictment", Office of Health, Safety and Security, June 2010

[19] "Bankruptcy and Globalisation in the Global Automotive Supply Industry", http://www.prtm.com

[20] "IATA: The Impact of September 11 2001 on Aviation", IATA, p. 3

[21] "E. coli: EU vegetable producers hit hard", www.bbc.co.uk, 8 June 2011

[22] "Spain calls for compensation after being 'wrongly' blamed for E. coli cucumbers", http://www.telegraph.co.uk/, 31 May 2011

[23] Wilson, John S., Catherine Mann and Tsunehiro Ostuki, 2004, "Assessing the Potential Benefit of Trade Facilitation: A Global Perspective", Working Paper 3224, Washington DC: World Bank

[24] "WTO keeps faith with stalling Doha talks", www.ft.com, 1 May 2011

[25] World Economic Forum report Global Risks 2012, World Economic Forum, Jan 2012

Risks to Watch

The expert group designated as "risks to watch" two risks that were repeatedly identified during workshops and interviews as being relatively unclear regarding their future impact. Both are associated with technological and infrastructure disruptions, where the systemic failure of critical information and transport infrastructure could negatively impact industrial production, public services and the movement of goods and people.

- **Information/Communication disruptions.** In the November 2011 Supply Chain Resilience Survey, 41% of respondents experienced disruptions as a result of unplanned outages of IT or telecommunication systems.[26] With increasing reliance on online systems and the growing sophistication of cyber attacks, information/communication disruptions could potentially have a high global impact across supply chain and transport networks. Increased reliance on and use of electronic data for real-time risk assessment, such as electronic manifests for cargo and advanced passenger information for air travel, have proven effective in facilitating movement of freight and people but, at the same time, put more pressure on governments and businesses to maintain robust and secure information and communications networks that ensure a high degree of data integrity.

- **Infrastructure failure** – Critical infrastructure, from roads to power stations, is increasingly under pressure due to lack of investment and prioritization of future resiliency. A report in 2009 by CIBC World Markets estimates that total infrastructure spending over the next 20 years will need to reach between US$ 25 trillion and US$ 30 trillion.[27] In the US alone, the American Society of Civil Engineers estimated the cost of repairing national infrastructure at US$ 2.2 trillion over the next five years.[28] The disruption or failure of critical infrastructure nodes could have severe impact on global networks, and needs to receive global attention and investment accordingly.

The near-term memories of recent events continue to dominate thinking about future risk based on past experience. However, it is important for the public and private sectors to be visionary in looking forward to what other risks could emerge with potentially disastrous impact on global supply chain and transport networks.

While likely types of disruption can be identified, the precise nature of systemic disruptions to global supply chain and transport networks is hard to predict. The expert group therefore emphasized that planning for a specific trigger event is not as important as having the inherent resiliency, flexibility and adaptability within networks to be able to quickly respond and recover regardless of the type of disruption.

> **The goal is not to predict what or when – but instead be prepared and able to respond in an informed and planned manner to minimize the impact of a disruption.**

Steven Culp
Global Managing Director, Accenture Risk Management

[26] "Supply chain resilience 2011, 3rd Annual Survey", Business Continuity Institute, Nov 2011, p. 6
[27] "Occasional Report #66", CIBC World Markets, Jan 2009, p.1
[28] "2009 Report Card for America's Infrastructure", American Society of Civil Engineers (2009)

The evolving nature of supply chain and transport networks and business models has led to changing risk distributions

Supply chain and transport networks have continuously evolved to deliver capacity, speed, efficiency and customer service through organizational trends such as globalization, specialization, volume consolidation and information availability. The focus on cost optimization has highlighted the tension between cost elimination and network robustness – with the removal of traditional buffers such as safety stock and excess capacity.

These developments have shifted risk distributions. As Figure 3 shows, their effects have often included sharing risk more broadly around the world, reducing high-frequency risks and focusing risk within sectors, common technologies or nodes. Another common feature has been to disassociate risk from responsibility, misaligning incentives and creating moral hazards – the notion that a party that is insulated from risk will behave differently from how it would behave if it had full exposure to risk.

Figure 3: Recent trends in supply chains

Trend	Example	Risk Impact
Globalization	Outsourcing, offshoring	Local concentrated risks become globally diffused, involving multiple actors
Specialization	Geographical concentration of production	Efficient process can be easily disrupted by localised event
Complexity	Product/network complexity	Reliance on multiple parts/players in diverse locations reduces visibility and adds latency into monitoring systems
Lean processes	Single sourcing, buffer stock reduction	While initially efficiency is improved and costs are lowered, fewer alternatives in case of disruption
Information availability	Track and Trace	Systems increasingly reliant on information flow
Government legislation	Air cargo screening, C-TPAT	Measures can impede efficient flow of supply chain and transport networks

Source: World Economic Forum and Accenture research; expert group findings

As organizations look for efficiencies and cost reduction opportunities in supply chain and transport processes, they need to be aware of the potential impact on their risk profile. For example, Southwest Airlines' strategic decision to operate a uniform aircraft type enables the company to reduce costs associated with maintenance, spare parts and training. However, when a hole appeared in the roof of one aircraft in April 2011, the airline had to ground the entire fleet of 79 aircraft and cancel 300 flights while the fault was investigated.[29] Comparable risks arise when the public sector seeks efficiency savings – for example, single-source contracts currently account for 40% of all the United Kingdom's Ministry of Defence.[30] It is critical for both the public and private sectors to understand and mitigate risks at every juncture of supply chain and transport networks.

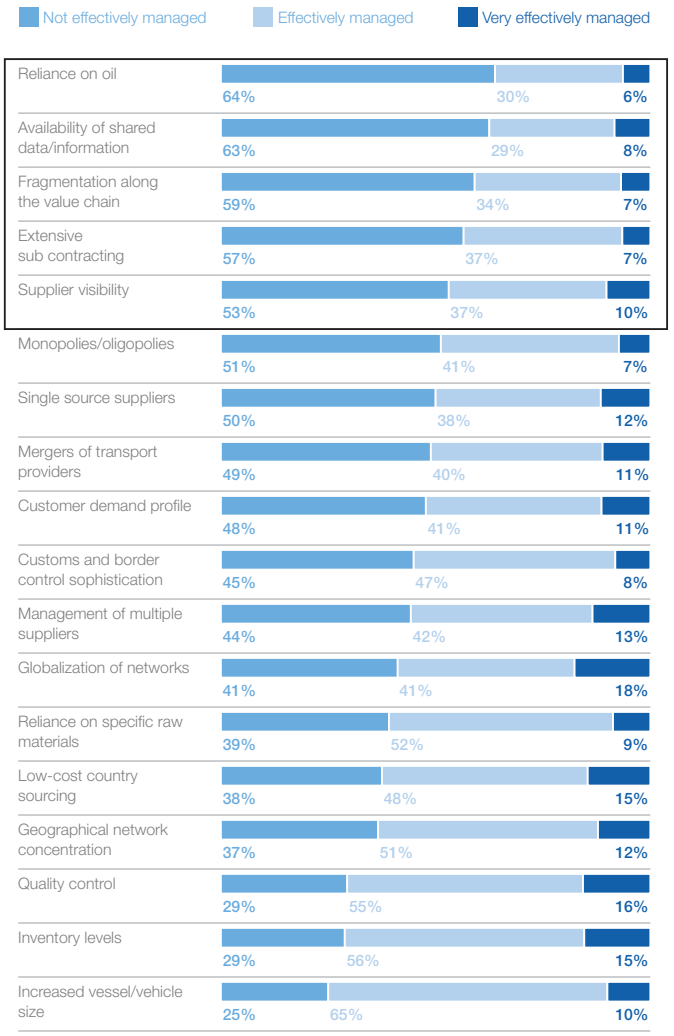
The increasing vulnerability of supply chains requires a new focus on managing and mitigating risk, which extends beyond the four walls of the single firm. It requires a much greater level of awareness of where the risks lie.[31]

> **Given the impact that a supply chain failure can have on the performance and reputation of an organization, it is no longer good enough in respect of critical supply chains just to look at tier one suppliers.**
>
> Nick Wildgoose
> Supply Chain Product Leader for Global Corporate, Zurich Financial Services

Supply chain and transport network vulnerabilities can magnify the impact of disruption

The expert group identified the five most concerning aspects of supply chains and transport networks, in terms of their current management, and capacity to magnify the impact of external disruptions (Figure 4). Four of the top five areas of vulnerability relate to visibility and control along long and complex supply chain networks. Three of the top five vulnerabilities deal with managing multiple players in the ecosystem.

Figure 4: Least effectively managed supply chain components



Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

Reliance on oil was identified as the greatest vulnerability and an immediate change in oil availability as a result of external disruptions such as civil unrest, terrorist attacks, strikes or export restrictions could have an extensive global impact on supply chain and transport networks. This vulnerability is a subset of a broader, longer-term challenge of addressing oil reliance, which is already receiving extensive attention through sustainability and future energy initiatives such as the United Nations Conference on Sustainable Development in June 2012.[32]

The network vulnerabilities identified by the expert group remain largely within the long-term control of supply chain and transport network participants. However, the strategic and operational decisions required to build resiliency are often beyond the direct control of any one player and need to be the focus of collaborative activity. This requires the support of senior leadership in the organizations concerned.

[29] "Southwest Airlines grounds jets over mid-air hole scare", www.bbc.co.uk , 2 April 2011

[30] "Review into single-source military equipment contracts published", http://www.mod.uk, 10 October 2011

[31] Peck, H. & Christopher, M., "The Five Principles of Supply Chain Resilience", Logistics Europe (February 2004), p. 21

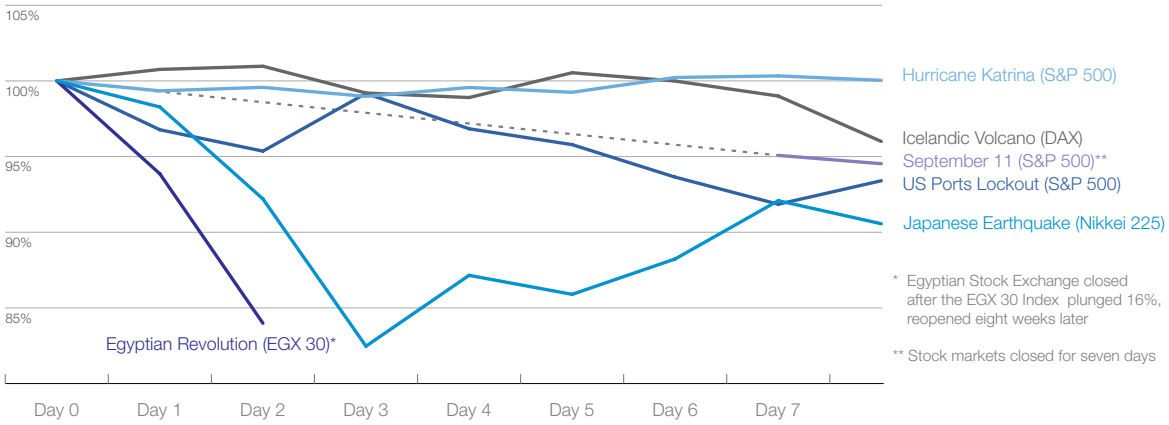
[32] United Nations Conference on Sustainable Development, http://www.uncsd2012.org

Lack of visibility and quantification of risk exposure impedes more effective risk management across supply chains and transport networks

Improving the effectiveness of risk management across supply chains and transport networks requires risk exposure to be better quantified and made more visible. Companies struggle to quantify the risk exposure of their own organizations due to a lack of understanding, standardized metrics and relevant and up-to-date data on supply chain risk; without a platform to share data and information, assessing systemic global exposure is difficult.
A study between June and August 2011 by the Business Continuity Institute, Chartered Institute of Purchasing and Supply, Zurich and DHL found that 85% of respondents had suffered at least one significant supply chain disruption in the last 12 months.[33] However, the impact of disruptions on corporate performance is often insufficiently understood and quantified: 26% of the respondents to the Forum's supply chain and transport risk survey could not estimate the financial impact of disruptions on their business.[34]

While supply chain risk management metrics are still largely unrefined, the financial impact of risk can be indirectly estimated. One indication is the pronounced effect on stock markets in the days following an external disruption to supply chains and transport networks, as illustrated in Figure 5. During the Egyptian uprising, the EGX 30 Index fell 16% in two days, while the Japanese earthquake and tsunami resulted in the Nikkei Index dropping 10.6%. Following the reopening of the stock markets seven days after the 11 September terrorist attack, the S&P lost 11.6% over the subsequent four days.[35]

Figure 5: Stock market responses to global events



Source: World Economic Forum and Accenture market analysis

Other indications come from analysing performance data at the company level. A study by academics Singhal and Hendricks in 2005 tracked the impact of 885 operational supply chain disruptions within publicly traded companies from 1992 to 1999. This study revealed a significant financial impact on performance, as operating income dropped by 107%, return on sales by 115% and return on assets by 92% (Figure 6).[36]

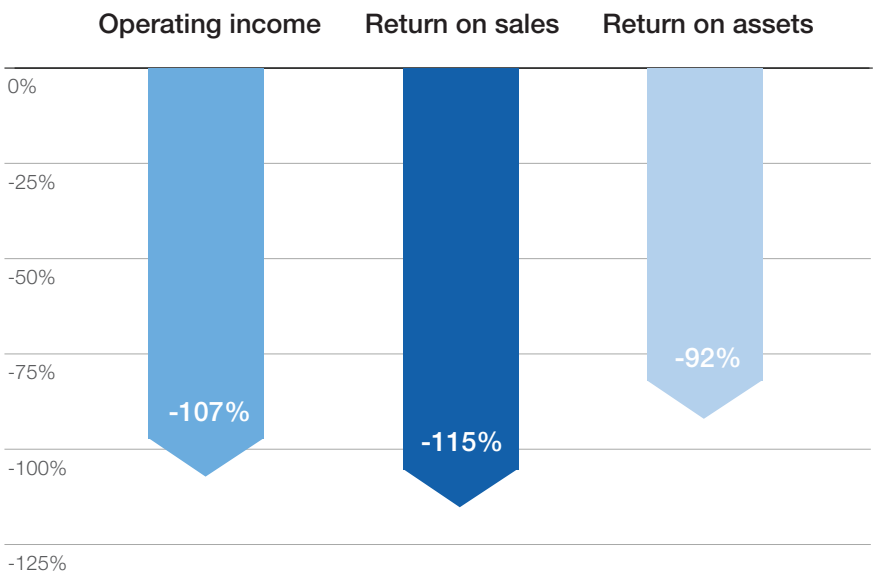
[33] Supply chain resilience 2011, 3rd Annual Survey", Business Continuity Institute, November 2011, p. 4

[34] World Economic Forum Supply Chain and Transport Risk Survey 2011

[35] World Economic Forum and Accenture market analysis

[36] Hendricks, K. (Wilfrid Laurier University) and Singhal, V. (Georgia Institute of Technology) "Association between Supply Chain Glitches and Operating Performance", Management Science (May 2005), p. 710

Figure 6: Change in control-adjusted operating performance of sample firms following supply chain glitches



Source: Singhal and Hendricks Study 2005

The Forum's expert group also identified a considerable impact on revenue following a disruption, with 30% estimating losses of at least 5% of annual revenue as a result of supply chain disruptions.[37] Accurately measuring and comparing both the costs and benefits of global risks could enhance commercial and regulatory decision-making, and the subsequent associated value of future investment in risk mitigation solutions.

Disruptions can also have a significant impact beyond corporate financial performance

The impact of disruptions to supply chain and transport networks is not solely restricted to immediate financial performance. Organizational reputation can also suffer lasting damage due to delays and failures in delivery of products or services and poor quality or unsustainably sourced products and goods.

Nor are reputational and financial implications restricted to the private sector. Governments need to respond to a disaster in a coordinated and effective manner not only to ensure the expeditious resumption of the flow of trade, but also to prevent criticism if their response is perceived as inadequate. The Japanese government was widely criticized for the lack of quick and authoritative communication on the current state of knowledge after the March 2011 tsunami caused a nuclear meltdown at Fukushima, which caused rumours and speculation to spread rapidly.

Flooding in Thailand in 2011 resulted in over 500 deaths and significant disruptions to supply chain networks, particularly in the automotive and technology industry sector. The impact has been felt at the regional level, with the Thai central bank reducing its gross domestic product growth forecast for 2011 from 4.1% to 1.5%, and the Thai baht depreciating by about 3.9% in three months.[38]

To ensure the expeditious resumption of the flow of trade following a disruption and to relieve negative media attention, it is critical for governments to ensure a coordinated and effective response during and after a disaster.

[37] World Economic Forum Supply Chain and Transport Risk Survey 2011

[38] "Thailand GDP Growth Accelerates; Flooding Threatens Slump", Bloomberg, 28 November 2011, http://www.businessweek.com/news/2011-11-28/thailand-gdp-growth-accelerates-flooding-threatens-slump.html

Mitigating Risk and Building Resilience

To effectively manage supply chain and transport risk, greater collaborative focus is needed

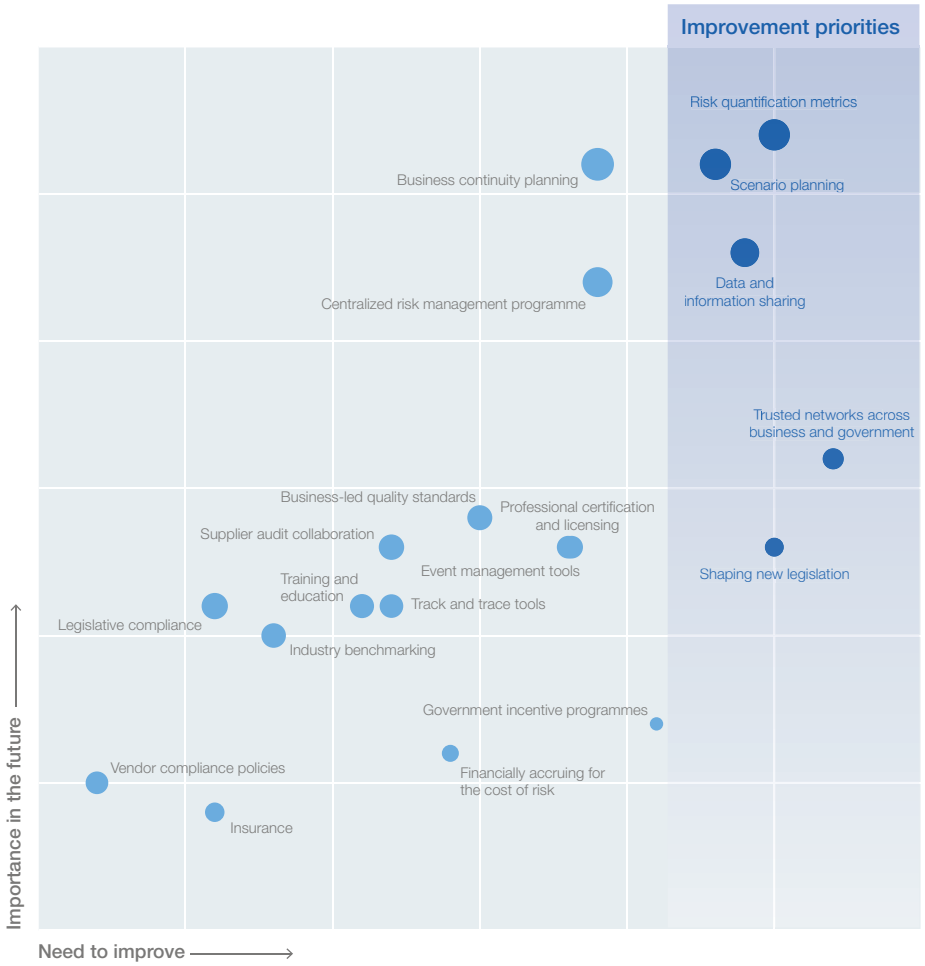
Multistakeholder opportunities to improve risk management

The expert group identified a number of priority areas where improvements are needed to effectively manage systemic supply chain and transport risk (Figure 7). Survey analysis focusing on the difference between the risk management methods available today and those most important in the future enabled the identification of the five specific mitigation methods requiring further development.

Experts noted that these priority risk management areas are not mutually exclusive; implementation might be enhanced by thinking of these tools as part of a set of management measures (Figure 8). The first step for businesses and governments will be identifying and developing the trusted networks integral to effective collaboration.

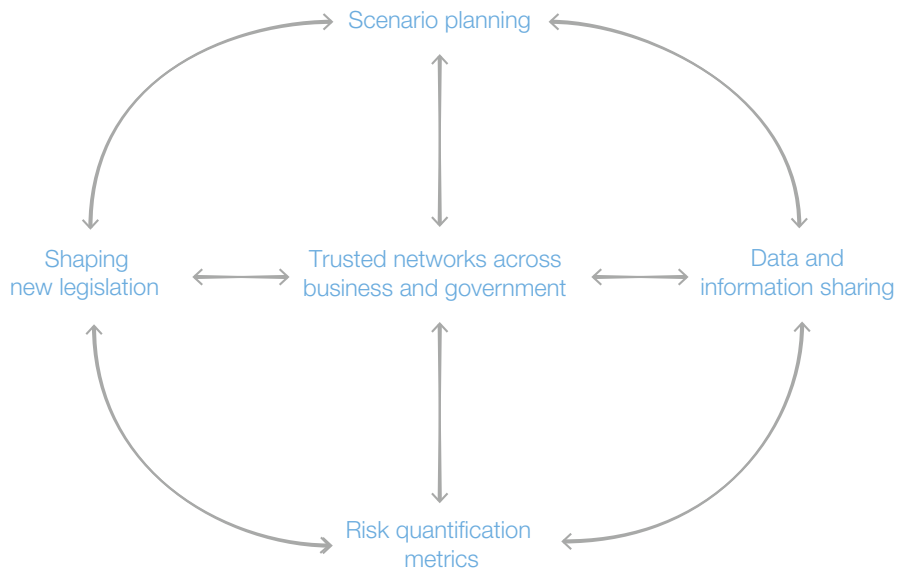
Bringing together different public and private sector entities will allow greater sharing of data and information, enabling organizations to better understand and quantify supply chain and transport risks. This in turn will inform public and private sector investment in areas of vulnerability and facilitate the development of proactive and effective legislation, as will the collaboration of key players from across companies, regions and sectors in multistakeholder scenario planning.

Figure 7: Risk management priorities



Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

Figure 8: Risk management strategies



Source: World Economic Forum Supply Chain and Transport Risk Survey 2011

Trusted Networks across Business and Government

Effective identification and management of systemic risk across the end-to-end supply chain requires a high level of collaboration between businesses, professional bodies, governments, regulators, suppliers, customers and even competitors. Carefully managed sharing of information, expertise and priorities can develop collaborative and trusted relationships, which are crucial to pre-disruption preparation and post-disruption rapid response, as well as improve the other four risk management methods prioritized by the expert group.

There is considerable enthusiasm for developing greater collaboration between business and government at the global level on supply chain and transport risk, recognizing that the nature of global disruptions means there are too many economic, security and political issues to take a siloed approach to risk management. However, aligning priorities and agreeing on focus areas will inevitably be a gradual process and will require substantial input from both public and private sector leaders. There are also immediate opportunities for greater understanding and coordination at the industry and/or regional level, as illustrated by initiatives such as the Supply Chain Risk Leadership Council, which comprises manufacturing and services supply chain firms working together to develop and share supply chain risk management best practices.[39]

The Forum's Risk Response Network (RRN) was launched in 2011. It supports the development of trusted networks by tapping into a diverse and high-level group of domain experts and by supporting their collaboration through risk analysis and tools for improving risk mitigation and resilience across supply chain and transport networks.

The Logistics Emergency Teams[40] supporting the UN's Joint Logistics Cluster are a practical example of companies teaming up with government to reduce supply chain risk and improve response. They recognize the value of advanced assessment, preparation and relationship building in responding to humanitarian disasters. The Logistics Emergency Teams are now viewed as standby partners by the UN and have been deployed around the world.

> **"Systemic supply chain and transport disruptions are manifested by a breakdown of the market. The Logistics Emergency Team response is a way to connect commercial professionalism and guidelines for conduct to situations of market breakdown."**
>
> Wolfgang Herbinger
> Director, Logistics, World Food Programme

Legislation and Regulation

Simplifying, internationally harmonizing and implementing effective legislation is a key concern across industry groups. Aligning legislation and regulation with modern industry practices is essential to improved risk management. However, poorly targeted legislation and regulation also has the potential to unintentionally and unnecessarily exacerbate disruptions to supply chain and transport networks.

When Iceland's Eyjafjallajökull volcano erupted in 2010, the reactive response of European transport ministries and civil aviation authorities resulted in uncertainty and delays in restarting air traffic. This was primarily a function of the failure to recognize in advance the potential threat presented by volcanic ash clouds from Iceland, the inflexible nature of existing aviation protocols and the absence of any pre-existing agreement on safe ash levels.[41] By the time the Grimsvötn volcano erupted in May 2011, contingency plans had been established and recommendations developed for managers on balancing the potential impact on airspace with safety. Giovanni Bisignani, Director-General Emeritus, International Air Transport Association (IATA), noted that the "European crisis coordination structure is facilitating a much more effective management of the ash crisis at the working level".[42]

Conducting risk assessments and cross-company scenario planning will enable policy-makers and industry to proactively identify network vulnerabilities and confer in the design of new legislation and regulation. Further collaboration between regulators and business is then required to address the inevitable challenges associated with the implementation of legislation and regulation, and to optimize intended benefits.

Data and Information Sharing

Access to accurate and reliable information can ensure a clearer global picture of supply chain networks' vulnerabilities and support the harmonizing of back-up plans in the event of a disruption. Identifying reoccurring risks at the industry level can also help businesses and governments focus efforts on increasing network resilience. However, the availability of shared data and information was identified as being ineffectively managed by 63% of survey respondents.[43]

Improving the two-way flow of information between businesses and government was identified as a particular priority, given that 24-hour global news media can rapidly spread inaccurate or out-of-context information. Two specific actions were suggested by the expert group: establishing reliable dashboards for macro-level flows and disruptions through key infrastructure; and increasing the flow of information across end-to-end networks to improve transparency at all tiers of the supply chain.

At present, there are limited tools and software available to support extensive data and information sharing. However, Yossi Sheffi, Professor of Engineering Systems and Director, Transportation and Logistics, Massachusetts Institute of Technology (MIT), stated that "there is a new class of software products being developed both internally by companies and by software houses to deal with supply chain risk". These products aim to identify high-probability and high-impact risks and organize preparation for such disruptions. They also create an alert system for all types of disruptions where early detection is likely to help organize and prioritize the response.

[39] Supply Chain Risk Leadership Council, http://www.scrlc.com/

[40] Logistics Emergency Team, www.logisticsemergency.org

[41] Sammonds, P., McGuire, W., & Edwards, S. (Eds.). "Volcanic Hazard from Iceland: Analysis and Implications of the Eyjafjallajökull Eruption", UCL Institute for Risk and Disaster Reduction, London (2010)

[42] IATA. May 2011. "Europe's Response to Grimsvotn - Formal Agreements Needed to Cement Progress" [Press release]. Retrieved from http://www.iata.org/pressroom/pr/pages/2011-05-24-01.aspx

[43] World Economic Forum Supply Chain and Transport Risk Survey 2011

Quantification Metrics

Workshop participants identified the importance of being able to quantify and measure the risk exposure of supply chain and transport networks. A lack of metrics has left companies struggling to quantify the risk exposure of their own organization or to compare providers.[44]

A recognized set of supply chain and transport risk quantification metrics needs to be developed to enable businesses and governments to obtain an accurate understanding of risk to networks, better prioritized risk management activities and alignment of incentives, exposure and risk appetite. As far as possible, these risk metrics should be consistent within and across organizations to enable comparisons. In the commercial sector, the revenue or gross profit at risk as a result of supplier failure is a useful measure to help senior management understand their risk exposure.

Scenario Planning

Scenario planning is currently used effectively at the operational level, and has the potential to play an integral role in reducing systemic risk across networks. Conducting scenario planning on a regular basis ensures that external risks and network vulnerabilities are continually reviewed and that the associated mitigation controls are effectively updated.

ABB's enterprise risk management process gathers input on risks in ways that are both bottom-up (from countries and business units) and top-down (from headquarters, divisions and regions). The top risks are identified and consolidated at group level – before being evaluated and analysed based on their relative likelihood and impact.

In 2010, this process enabled ABB to identify concerns about earthquakes in Japan and political upheaval in Egypt. Both country management teams were trained in crisis management and took part in simulated scenarios to test their systems, communications and teamwork. By the end of Q1 2011, both teams had to put this training into real action as they worked with ABB Group and region crisis task forces to account for personnel, get them to safety, assess the impact on the business and return operations to normal as quickly as possible.

While this assessment was completed at the enterprise level, the process of identifying and consolidating risks and then conducting focused scenario planning and training on those high-impact/high-likelihood events, could be scaled to incorporate multiple players across a region or industry.

Scaling scenario planning to the multistakeholder level enhances understanding of external environments while contributing to better anticipation of actions by network partners and improved joint preparation of continuity plans. Scenario planning at the regional and/or sector level can enable areas of conflict and lack of coordination to be identified, clarify the roles and responsibilities of public and private actors in the face of major global disruption, and thereby increase the speed and effectiveness of response. Stress testing of critical infrastructure would enable greater public and private sector understanding of infrastructural resiliency in the event of a disruption.

The trusted networks discussed above can increase the scope and effectiveness of scenario planning, driving effective risk management and investment in contingency solutions and helping to proactively shape global legislation and regulation. A notable example is the Singaporean government's effective use of scenario planning to bring together key regional players from the public and private sectors to identify areas of vulnerability and future improvement opportunities.[45]

These priorities for improved risk management identified by the expert group will require concerted collaboration by both the public and private sectors.

[44] Over 25% of the respondents to the World Economic Forum survey do not know the annual financial impact of disruptions on their business

[45] Singapore Economic Development Board, www.edb.gov.sg

> **"It is critical for government and businesses to work together to understand risks to supply chain and transport networks, and develop new solutions and best practices for risk management. Organizations have a great opportunity to increase the resilience of global networks, and key players within the public and private sectors must move collaboratively towards a new model of supply chain risk management."**
>
> Kelvin Wong
> Executive Director, Logistics and Professional Services, Singapore Economic Development Board

First Steps towards Implementation

The Forum expert group emphasized the requirement for significant interaction between business and government to drive improvement in the risk management methods identified. The following opportunities have been suggested as possible next steps in moving towards a new model for addressing supply chain and transport risk:

- Working groups led by regional trade ministries driving action in regional hubs
- Disruption-level evaluation frameworks – agreement on standardized classification of the impact of a disruption on supply chain networks, which would then inform the response of the public and private sectors during and after an event
- Evaluation of national risk-response maturity as part of trade and travel openness rankings

Recommendations

Five recommendations have been identified for business and government to address systemic supply chain and transport risk

Five Recommendations for Government and Business

Systemic supply chain and transport risk should be more effectively managed through multistakeholder action and collaboration. The key actors are the supply chain and transport industry itself, its customers and government.

Government	1. Improve international and interagency compatibility of resilience standards and programmes
Business	2. More explicitly assess supply chain and transport risks as part of procurement, management and governance processes
Joint government and business	3. Develop trusted networks of suppliers, customers, competitors and government focused on risk management
	4. Improve network risk visibility, through two-way information sharing and collaborative development of standardized risk assessment and quantification tools
	5. Improve pre- and post-event communication on systemic disruptions and balance security and facilitation to bring a more balanced public and private sector discussion

Call to Action

Systemic disruptions to global supply chain and transport networks have serious consequences for the movement of people and goods, the backbone of local, national and global economies.

Ensuring optimal levels of supply chain and transport risk exposure, security and resilience require improved multistakeholder understanding and actions.

Participants in the World Economic Forum's Supply Chain and Transport Risk Initiative call for broader collaboration to identify and effectively manage global supply chain and transport risks through the implementation of the recommendations set out in this report.

Appendices

Appendix 1: Existing Risk Management Tools and Processes

There are existing tools and processes to support supply chain risk management, although predominately focused at the operational level

An awareness of the importance of circumscribing, measuring and managing risk is growing. In response, a number of tools, processes and governmental and professional initiatives have been developed that aim to reduce the impact of disruptions on supply chain and transport networks.

Figure 1: Existing risk mitigation tools (non exhaustive)[46]

Internal company tools	Cross-company tools	Professional bodies	Government bodies and initiatives
– Track and trace tools – Risk mapping/ prioritization – Business continuity planning – Scenario planning – Event management tools – Centralized risk management unit/ personnel – Centralized/ standardized supplier assessments – Supplier codes of conduct – Quantification metrics – Employee training initiatives – Supply chain mapping – Business impact analysis tools	– Supplier audit collaboration – Standardized certifications (e.g. BSI development on supplier continuity planning) – Disruption News Feeds	– Industry associations, e.g. Retail Industry Leaders Association (RILA), International Air Transport Association (IATA) – Supply Chain Risk Leadership Council – Professional associations, e.g. Chartered Institute of Logistics, Business Continuity Institute, Chartered Institute of Purchasing and Supply – Supply Chain Council and SCOR model – ISO28000	– Customs authorities – WCO SAFE Framework and AEO – Federal Emergency Management Agency – International Civil Aviation Organization – Department of Homeland Security (US) – UN Declaration of Human Rights/Global Compact – Security initiatives, e.g. CT-PAT – EU/US competition law – World Food Programme – World Health Organization – Department of Trade and Industry initiatives – Authorized Economic Operator Programme – PS-Prep Programme – Environmental legislation

However, the sophistication and effectiveness of these tools are varied for the following reasons

– Significantly different levels of adoption between companies – risk management initiatives are up to the individual company's discretion
– Mitigation tools and processes are often devised and/or applied on a local or regional basis, resulting in less globally cohesive risk management
– Minimal formal standardization or certification exists in this area
– Laws and certification that do exist are often drawn up in isolation from industry insight, or are not integrated into company processes

[46] Identified by World Economic Forum survey, interview series and expert group

Appendix 2: Report Methodology

The World Economic Forum's New Models for Addressing Supply Chain and Transport Risk report is based on a multifaceted analysis of the risks to the supply chain and transportation industry. It has been developed from a wide range of sources, including published studies, an online survey, input from executives participating in the World Economic Forum's Industry Partnerships programmes in mobility (automotive, aviation and logistics), and an interview series with some of the world's foremost academic, industry and government experts.

Participant description

Between April and December 2011, the World Economic Forum worked with supply chain and transport experts from business, government and academia across a range of regions and sectors. The expert group encompassed a diverse group of experts through a variety of engagement methods:

- A series of six workshops, in New York, Cape Town, Vienna, Dalian, Abu Dubai and Singapore, bringing together over 100 individuals from a wide range of backgrounds
- An interview series with 40 individuals across 32 organizations; these one-on-one discussions enabled a more detailed insight into the key concerns and best practices across the public and private sectors
- A survey involving 55 individuals from a wide range of backgrounds, including logistics, healthcare, aviation, automotive and government

Appendix 3: Terms and Definitions

Terms	Definitions
Border delays	Delays and restrictions to the free movement of goods and people across international borders due to screening programmes, customs clearance or immigration controls
Commodity price volatility	Severe price fluctuations that make critical commodities unaffordable, slow growth and increase global tensions
Conflict and political unrest	Military action or aggressive foreign or trade policies on the part of global or regional powers that disrupt political or social instability, negatively impacting populations, investment and financial markets
Corruption	The abuse of power for personal gain by businesses and public officials that undermines the rule of law, governance, investment flows and economic development
Currency fluctuations	Global savings and investment imbalances that foster unsustainable current account imbalances, unsustainable levels of external debt and ultimately wide swings in foreign exchange rates
Energy shortages	The impact of sudden change to availability of energy, e.g. shortages in electricity supply following the 2011 Japan earthquake and tsunami or Russia shutting off gas supplies to Ukraine in 2009
Export/import restrictions	Restriction on the type and quantity of goods exported or imported within a specific country or countries by a government
Extreme weather	Storms, cyclones and other acute weather events that cause harm to lives, human health, infrastructure, property, economic activity and the environment
Illicit trade and organized crime	Unchecked spread of illegal trafficking of goods and people through the global economy; highly organized, disciplined and deep-rooted global networks, committing criminal offences
Information and communications disruptions	Single point system vulnerabilities that trigger cascading failure of critical information infrastructures and networks
Natural disasters	Earthquakes, volcanic action and other geophysical catastrophes that cause harm to lives, human health, infrastructure, property, economic activity and the environment
Nuclear/biological/chemical weapons	The availability of nuclear, chemical, biological and radiological technologies and materials intended to cause harm
Ownership/investment restrictions	Barriers to market entry, e.g. restrictions on airline ownership and control, cabotage rights
Pandemic	The incidence and patterns of both known and emerging infectious diseases that shift to new regions and population segments through a series of pandemics or sub-pandemic outbreaks, threatening global health and economic activity
Maritime Piracy	The spread of violence or depredation on the high seas, directly impacting the global passage of goods and people
Shortage of labour	A shortage of skilled and/or unskilled labour directly impacting the effectiveness of supply chain and transport networks
Sudden demand shocks	Sudden changes in demand across an industry or sector due to an external event, e.g. immediate decline in airline passenger travel post 9/11 or the decline in sales for the agriculture industry following the May 2011 E. coli outbreak in Europe
Terrorism	Individuals or a non-state group that successfully inflict large-scale human or material damage
Transport infrastructure failures	Cascading failure of critical transport infrastructure and networks
Water security	Decline in the quality and quantity of fresh water combined with increased competition among resource-intensive systems, such as food and energy production

Acknowledgements

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