Security of Supply, Case Finnish Ports

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Abstract: Security of supply involves all the activities that are undertaken to secure a nations' functioning and the welfare of its citizens in case of major disturbances and emergency situations. Maritime transports are very essential for Finland as over 80% of the foreign trade in the country is seaborne and possibilities to carry out these transports by other means of transport are limited. Any disruption in maritime transports has negative consequences to many sectors in the Finnish economy. With this paper we contribute to analysis on mitigation strategies of critical industries towards transport disruptions. Our case study concentrates on impacts of a port closure due to a strike in Finland in 2010 and companies' strategies to manage their operations during the strike, and we draw conclusions to the general structure of mitigation strategies towards logistic vulnerability. The strike stopped approximately 80% of the Finnish foreign trade. We carried out personal interviews with representatives of the companies in Finnish critical industries to find out about the problems caused by the strike, how companies carried out their transports and how they managed to continue their operations during the strike. As a result of the strike Finnish companies could not export their products and/or import raw materials, components and spare parts, or other essential supplies. During the strike companies did various actions to secure their supply chains. The companies raised their inventory levels before the strike began, they rescheduled or postponed their deliveries, shifted customer orders between production plants among the company's production network, or in the extreme case bought finished products from their competitor to fulfill their customers' order. Our results also show that possibilities to prepare against transport disruptions differ between industries.

Keywords: Security of supply, ports, strike, transport disruptions, mitigation strategies

1. INTRODUCTION

Security of supply involves all the activities that are undertaken to secure a nations' functioning and the welfare of its citizens in case of major disturbances and emergency situations. Emphasis is on preventive measures with the aim of safeguarding society's critical systems and ensuring availability of critical materials (Valtioneuvoston päätös huoltovarmuuden tavoitteista 21.8.2008/539). Sustaining security of supply requires an understanding of the material needs of the so called critical industries, their critical supply chains and transport needs. Critical industries provide the necessary inputs and services a society is dependent on, including energy production, food supply and health care, and these industries are an essential part of critical production. For export-oriented countries and for countries whose critical systems and industries are dependent on imported supplies the role of maritime transport is fundamental in ensuring security of supply. Furthermore, ensuring functionality of the ports is of particular importance because ports link sea and inland transportation serving as nodes in the intermodal or multimodal transport chain and they operate as logistics centres for the flow of cargo and passengers (Bichou & Gray 2005; Panayides 2006; Rodrigue et.al 2009; Hall & Jacobs 2010).

Only when there is a disruption along the maritime transport chain the true importance of the transports to societies becomes visible. A disruption is a sudden, unwanted event that interrupts the material flows in the supply chain stopping movement of goods causing negative consequences (Svensson 2000; Kleindorfer & Saad 2005; Craighead et. al 2007; Wilson 2007). Many authors stress that modern supply chains are more vulnerable to transport disruptions than ever before because companies regardless of industries have tried to improve their performance by optimizing their resources e.g. by getting rid of slack and by reducing their inventory levels. At the same time the companies have become more and more dependent on continuous transports. As the supply chains are often global, any disruption anywhere in the world can have an impact on the operations of the companies causing considerable financial loss (Herod 2000; Svensson 2000; Jüttner

et al. 2003; Norrman & Jansson 2004; Barnes & Oloruntoba 2005; Peck 2005). While risk mitigation strategies of the companies usually take into account high-likelihood, low-impact risks regarding their supply chains, typically arising from difficulties co-ordinating supply and demand, supply chains are also vulnerable to high-impact, low-likelihood risks, which affect organizations in a major way. Coping with high impact, low risk incidents also require a different kind of approach from a company (Chopra & Sodhi, 2004; Sheffi & Rice 2005; Kleindorfer & Saad, 2005; Peck 2005; Oke & Gobalakrisnan 2008). The volcanic eruption in Iceland in April 2010 stopping air traffic in the Northern Europe and the earth quake causing a tsunami in Japan in March 2011 are most recent examples of severe disruptions stopping transports and causing considerable harm to societies and companies' supply chains worldwide. These events proved the importance of being prepared for the unexpected (Evans 2011). Several devastating earthquakes and a large number of weather-related catastrophes made the year 2011 the costliest year ever in terms of natural catastrophe losses (Munich Re 2012).

As a response to the threats mentioned above a growing literature of supply chain vulnerability and disruption risk management literature has appeared, focusing on e.g. the causes or triggers of disruptions, risk assessment models and risk mitigation strategies (for a review see Ellis et al 2011). However, only a few studies have analysed the suitable mitigation strategies approaches towards maritime transport disruptions. Exceptions include Gurning & Cahoon's (2011) study on the Australian wheat supply chain and the effectiveness of mitigation strategies in case of a disruption and Wilson's study on the impact of transportation disruptions on supply chain performance (2007). Rodrigue & Slack (2002) analyse the linkages between logistics and national security, and Grubesic & Murray (2006) study the impacts of losing vital nodes in geographically linked networks. As accessibility and mobility are fundamental to globalized society, more attention should be paid to the meaning of maritime transport for security of supply for the societies and for the companies' supply chains, and how both companies and societies could protect themselves against transport disruptions. More empirical research is also needed to address mitigation strategies for different kinds of risks in supply chains (Oke & Gobalakrisnan 2009).

With this paper try to answer the call for empirical research focusing on what mitigation strategies companies actually use when facing a transport disruption. We analyse the impacts of a strike closing all the main ports in Finland in the spring 2010. The closure of the ports due to a strike can be considered as risk with a moderate likelihood with potentially high impacts (see Vilko et al. 2011, 42-54). We focus on how companies in selected Finnish critical industries carried out they transports and how they managed to continue their operations during the strike, and we draw conclusions to the general structure of mitigation strategies towards logistic vulnerability. The paper is based on results of a larger research project focusing on maritime cargo flows of the Finnish critical industries, risks regarding these transports and the companies' preparedness towards disruptions and emergencies concerning their supply chains (see Tapaninen et al. 2009; Saranen 2010; Vilko et al. 2011; Kämärä et al 2011; Yliskylä-Peuralahti et al. 2011a; Yliskylä-Peuralahti et al 2011b).

2. RESEARCH METHODS

The results discussed in this paper are based on a qualitative study following a case study methodology (Eisenhardt 1989; Yin 1999; Yin 2003). We conducted 19 semi-structured personal interviews during the period 25.3.-11.6.2010 with representatives of the companies in the Finnish critical industries. When selecting industries and companies to be included to this study, we have followed Finnish National Emergency Supply Agency's (NESA) definition of critical sectors, excluding national defense because of its specialized character. Therefore, critical industries analysed in this report include energy production, food sector, healthcare and export industries, of which forestry, technology and chemical industries form the main groups investigated. Themes discussed during the interviews included:

- Transport routes and modes used, volumes of materials transported and most important ports
- Management of problems and disruptions: How did the companies prepare themselves to a situation where the transport mode or route they normally use cannot be used, and what alternatives they had

during the strike? How did the companies ensure their continuous operation despite disruptions? How did they inform their suppliers and clients?

- Strategic position of the respective company in the markets and in its supply chain: how specialized is the production (e.g. each factory produces certain products only), how much flexibility does it have in its sourcing and is it e.g. the sole supplier to its clients?

The interviews were conducted at the premises of the companies and taped on the permission of the interviewees. The persons interviewed are responsible for transport and logistics operations. Five interviews were group situations, where several persons from the same organization were present. The companies included in the research (Table 1.) are the main users of ports, transporting considerable volumes. All of the companies have international sales and several production sites outside Finland, and with the exception of five companies they all are publicly listed. Eleven of the companies have their headquarters in Finland, 6 of the companies are affiliates of foreign-owned companies, 2 affiliates of Finnish-owned corporations.

Table 1. Industries included in the research.

Industry	**Number of companies**	**Of which public**	**Number of employees**	**Turnover 2009**	**Number of sites outside Finland**
Energy production	2	2	5 000−14 000	5−10 billion €	10−20
Food supply & food exports	5	2	1 000−10 000	< 5 billion €	< 10
Chemicals (info on 1 company not available)	4	2	5 000−10 000	< 5 billion €	10−50
Pharmaceuticals & healthcare supplies	4	3	1 000−10 000	1−10 billion €	10−20
Logistics/freight forwarding (whole company globally)	1		> 15 000	11−30 billion €	> 100
Forestry	1	1	> 15 000	5−10 billion €	> 10
Metals	1	1	5 000−14 000	< 5 billion €	> 20
Electronics (whole corp.)	1	1	> 100 000	> 30 billion	> 100

(Note: As the number of companies was small the number of employees and annual turnover has been expressed as a class so that individual companies could not be recognized. Data on affiliates of multinational corporations was not available separately, and we have used figures for the whole corporation.)

Our analysis of the interview material is based on classifying the content of each (transcribed) interview according to the above mentioned themes, and finding similarities and differences between different companies. We concentrated especially on the consequences of the strike on the companies' operations and how the companies ensured continuity of their operations. We used also written sources including information published at the companies' www-pages and newspaper articles to complement the information our interviewees gave us, and governmental reports to assess the import dependency of the Finnish critical industries.

3. THE CONSEQUENCES OF THE STRIKE ON TRANSPORTS

The strike of the stevedores at public ports in March 2010 (March 4–19th, 2010) stopped approximately 80% of the Finnish foreign trade. The strike was caused by disputes between Finnish Transport Workers' Union (AKT) and Finnish Port Operators' Association (Satamaoperaattorit ry) on working hours and severance benefits. The workers' union requested a compensation equivalent to one year's salary for laid-off workers. The port workers' union gave a strike warning a month before and the representatives of the employers and employees negotiated to solve their disputes. As a result the strike was postponed for two weeks (Kuusela 2010). Because of the strike Finnish companies could not export their products and/or import raw materials, components and spare parts. They had to find transport alternatives and ways to continue operations.

For a country like Finland a strike closing ports is very harmful, because nearly 80% of the country's foreign trade is transported by the sea and land transport options are limited. Majority of the Finnish maritime traffic is feedering to and from ocean ports Antwerp, Rotterdam and Hamburg in the Continental Europe, where

goods are either reloaded to/from inter-continental vessels, or from where they continue by other transport modes to their final destination. When public ports in Finland were closed because of the strike of the stevedores, the feeder vessels delivering the containerized goods to and from the overseas ports stopped running as there was no cargo to transport. Shipments in bulk form were only possible via private, industry-owned ports. During the strike, Finnish companies could either try to transport their goods by road via Sweden, or use liner ferries running between Finland and Sweden, Finland and Estonia, or Finland and Germany or use Swedish and Estonian ports for their shipments. To load the goods into ferries, the road haulage companies had to use their own drivers to drive truck and trailer combinations into ferries. Alternative routes by land via Sweden, ferry routes from Finland to Estonia, Sweden and Germany and the Via Baltica land route from Estonia to Poland are depicted in Figure1. As the figure shows, Finland also has a land border with Russia but strict border regimes makes passing it difficult. Borders with Sweden and Norway in the North are open but the longer distance makes this land route uneconomical. However, companies did use the land route via Sweden during the strike when they could not use their normal maritime transport route.

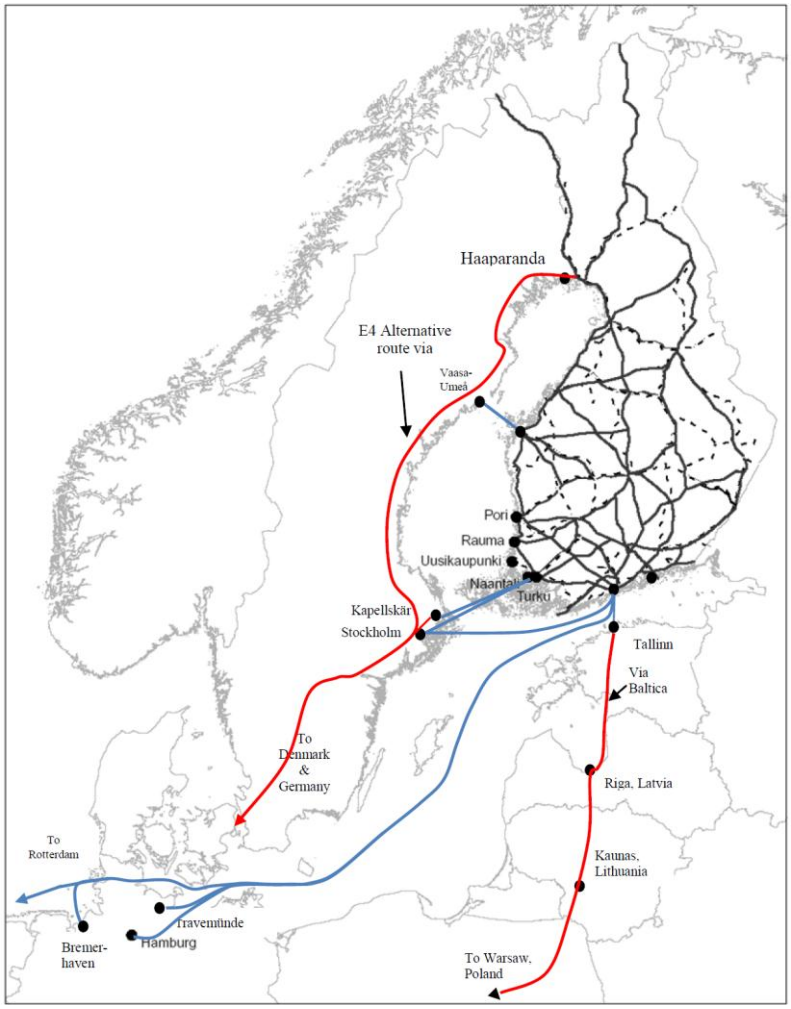

Figure 1. Main sea transport routes of the Finnish foreign trade and land transport alternatives

4. THE WAYS OF COPING DURING THE STRIKE

There are various strategies companies can use either before and/or during a disruption. Strategies that are used before a disruption occurs are mitigation strategies, and the actions taken when the disruption takes place are contingency measures (Tomlin 2006). Contingency rerouting and inventory/sourcing mitigation strategies are most often referred as suitable strategies for maritime transport risks (Gurning and Cahoon

2011). During the stevedore strike Finnish companies did all they could to secure their procurement and delivery of the final products. Most companies were able to supply at least their key customers with the most essential goods and materials. The companies used a combination of several strategies in order to do this. However, depending on the industry ways to cope with maritime transport disruptions can be quite limited. Many Finnish companies e.g. in energy production transport large volumes of coal and other sources of energy, whereas companies in the Finnish export industries transport goods with very specialized characters (e.g. chemicals or large and heavy equipment). Therefore, maritime transport cannot be replaced by any other transport mode. Having goods in stock ties capital so all the companies regardless of industry try to keep their stocks at a minimum. Reliability of the deliveries is thus the main concern for all companies. Preventive measures the interviewees used during the Finnish stevedore strike include:

- Raising inventory levels at their own and customers' sites before the strike began
- Changing the delivery schedule, e.g. making orders of incoming supplies earlier and/or postponing orders to customers if possible
- Changing the transport mode and route if possible
- Having spare capacity (e.g. in production or storage), using several transport companies
- Supplying the customer from another site (outside Finland) among the corporation's network producing the same or suitable products and transferring customer orders between the plants However, many companies have specialized production plants producing only certain products with no compensatory production elsewhere
- Buying finished or semi-products from a competitor to fulfil delivery contracts to customers in case the company's own production had to be stopped e.g. due to shortage of raw materials caused by the transport disruption.

Our companies thus used a mixture of inventory/sourcing mitigation strategies solely or in combination. Raising inventory levels and supplying the customer from another site belong to inventory/sourcing mitigation strategy and changing the delivery schedule, transport mode and route are contingency measures (Table 3). Our interviewees pointed out, that for a global company with multiple production units in different countries the international network can help e.g. in stock out situations. They argued that it would be harder for a smaller, non-global company to find solutions for logistics problems because they do not have alternatives available within their own organization. Interestingly, some companies were forced to apply extreme measures, such as buying finished products, to fulfil their customer orders. This clearly reveals how serious the situation was when the strike had lasted a few days.

Our results show that there is variation between industries regarding the possibilities carry out production after a disruption (Table 2) and how the companies are prepared against disruptions (Table 3). Products requiring temperature controlled transport, including pharmaceuticals and food, do not bear interruptions at all in the transport chain and are thus very vulnerable. Some industries, such as oil or chemical production, have constantly running processes and they are dependent on continuous, daily delivery of raw materials and continuous transports carrying finished products. Many companies in these industries have so large volumes of the raw materials and/or finished products that there is no realistic alternative for a ship to make the deliveries. Many of the companies in these industries are forced to either shut down or alter their production after 2-3 days. Contrary to Wilson (2007, 296), who argues that a transportation disruption is less severe event compared to e.g. an accident closing a factory because a transport disruption stops only the flow of goods in transit, our results show that a transport disruption closing several ports can have a major impact on the whole operations of a company, not only goods in transit.

Table 2. The critical length of disruption by industries

Industry	**How long production can be carried out after a disruption**
Energy production	*Coal*: 3 months (reserves by law 3 months)
	Oil production: **2−3** days (production process is then forced to put down), reserve stocks of critical products (corresponding the amount of imports for 90 days)
Food supply & food exports	*Grain imports & exports*: several months (can be stored)
	Meat: 2−3 weeks (with special arrangements)
	Animal feeds: 2−3 weeks (with special arrangements; if there is a breakdown etc. at a factory, it will have an immediate impact)
	Malt: several months (can be stored)
	Milk products: **2−3 days**
	Other food products: from 2−3 days (perishable products) to 2−3 weeks (based on the products)
Chemical industry	Approximately 2 weeks (with special arrangements); 2−9 days
Pharmaceuticals & healthcare supplies	Mandatory reserves by law industry & importers (3, 6 & 10 months) of critical supplies, hospitals (3−6 month stocks) Other supplies: 3 weeks to 2 months (products **that are not mandatory** to be kept in stocks by law)
Forestry	**12 hours−2 days**
Metals and miming	Depending on the product: from a few weeks to 2−3 months
Technology industry	**2−3 days**

Our results indicate there was variation between companies concerning what strategies and tactics they were able to use and how proactive or reactive (see Schmitt 2011) the companies are regarding their inventory/ sourcing mitigation (Table 3). Majority of the companies (11 out of 19) reported they made proactive inventory/sourcing mitigation measures before the strike began. Raising inventory levels at own and customers' sites was for many companies the first preparatory measure. These informants said their companies keep stocks to be able to supply large volumes of products constantly, to guarantee customer satisfaction and to be prepared for sudden peaks in their customers' demand. The chosen mitigation strategy among these companies is thus a more generic and aimed at also other risks, not only dealing with the strike. For 8 companies the measures chosen belonged primarily to contingency re-routing: postponing shipments/ taking incoming deliveries earlier, special arrangements (e.g. changing the transport mode and route, making contracts with trucking companies in order to have the drivers drive the cargo in a truck into a ship), making adjustments to production, and in the extreme case buying finished products from a competitor. The actions of these companies can be seen as more specific and tailored to the problems at hand. Due to the small number of the companies it was not possible to test whether the variation between the chosen mitigation strategy between industries and among companies in the same industry is statistically significant. Forthcoming studies should investigate further differences between companies in the same industry concerning how and why they choose a particular mitigation strategy and how proactive companies are in general towards many different threats and risks.

Table 3. Risk mitigation strategies of the case companies

Industry	**Risk mitigation strategy**
Energy production	**Company 1 (coal imports): inventory/sourcing mitigation** - several month's inventory + safety stocks - multiple sourcing (contracts 80-90%, spot markets 10 to 20%), - plans to widen the energy base (biofuels & domestic sources)
	Company 2: (oil) inventory/sourcing mitigation - raw materials sourced from different locations, several production sites in different countries - own & chartered vessels, term agreements used mostly in sales - some products sold also on spot markets
Food supply & food exports	**Company 3: (grain) contingency routing & inventory mitigation combined** - several ports can be used - postponing shipments/taking incoming deliveries earlier - multiple storage sites, farms keep their own stocks, extra storage capacity available

Industry	Risk mitigation strategy (continued)
Food supply & food exports	**Company 4:** (**meat & meat products) contingency routing** - re-routing and special transport arrangements when the strike began - adjustments made to production - stress direct communication & personal relations in disruption management
	Company 5 (animal feed & malt): inventory/sourcing mitigation - the company produces several different products, animal feed production most sensitive for disruptions - reserve stocks, excess capacity, and capacity to change production in emergencies - localised sourcing and contracts with farmers to reduce import dependency
	Company 6 (wholesaler of food & consumer products): contingency routing - several different products, lead times between products vary - re-routing deliveries, changing schedules and transport modes
	Company 7 (milk products): contingency routing + sourcing mitigation - contracts with several transport companies - multiple suppliers
Chemicals	**Company 8 (basic & specialty chemicals): inventory/sourcing mitigation** - increased inventory, several locations - continuity plans
	Company 9 (basic & specialty chemicals): inventory/sourcing mitigation + contingency re-routing - increased inventory, global sourcing strategy with alternative suppliers (but in some materials only 1 supplier) - changing the transport route & mode when the strike began
	Company 10 (basic chemicals, raw materials for plastics): contingency measures - supply contracts, vertical integration - continuity plans, communication internally and with suppliers & customers
Chemicals	**Company 11 (pigments & chemicals): inventory mitigation + contingency re-routing** - increased inventory, vendor managed inventory (VMI) used with suppliers - continuity plan, alternative routing & changing transport mode, back-up carriers
Pharmaceuticals & healthcare supplies	**Company 12 (pharmaceuticals): inventory/sourcing mitigation + contingency re-routing** - buffers, safety stocks, back-up suppliers - alternative routing, changing transport mode
	Company 13 (wholesaler of health care products): inventory/sourcing mitigation + contingency re-routing - safety stocks - several suppliers with multiple factory locations - several transport modes used
	Company 14 (wholesaler of pharmaceuticals): inventory/sourcing mitigation + contingency re-routing - safety stocks by law (3 & 6 months) - several transport modes used
	Company 15 (wholesaler of pharmaceuticals): inventory/sourcing mitigation + contingency re-routing - safety stocks by law (3 & 6 months) - alternative routing, changing transport modes
Logistics/freight forwarding	**Company 16: contingency re-routing** - re-scheduling and re-routing, communicating with customers
Forestry	**Company 17 (pulp & paper, sawn wood): contingency measures** - buying finished products - continuity plans will be made
Metals and mining	**Company 18 (metal products): inventory/sourcing mitigation** - several suppliers of raw materials, some spare capacities at production plants (ability to carry out production varies between products)
Technology industry (products for power & automation technologies)	**Company 19 (several products): contingency measures** - products produced to stock, engineered to order and configured to order - changing delivery schedules in case of problems

5. CONCLUSION

Supply chains are very vulnerable to transport disruptions because companies regardless of industries are trying to improve their performance by optimizing their resources, sourcing globally, and e.g. by reducing their inventory levels. All these measures increase the companies' dependency on frequent and reliable transport services. Any disruption anywhere in the world can have an impact on the operations of a company causing considerable financial loss. In an economy as dependent on maritime transportation as the Finnish one (over 80% of foreign trade transports) any malfunctioning of ports will have wide repercussions.

The stevedore strike in the spring 2010 made visible the Finnish society's dependency on maritime transports very concretely. When strike stopped loading and unloading at the public ports and thus majority of the Finnish foreign trade, the companies had to find alternative ways to carry out their transports in order to be able to continue their operations. Our results indicate there are notable differences between industries in this respect. Especially companies in the process industry faced difficulties, because the production processes in these industries is continuous, storage capacities are very limited and the production process is designed on the basis of continuous deliveries of incoming raw materials and finished products. Forthcoming studies should investigate further differences between companies in the same industry concerning how and why they choose a particular mitigation strategy and how proactive companies are in general towards many different threats and risks. For societal perspective studying how the continuity of the supply chains of the critical industries can be maintained during disruptions and how to coordinate the actions of the different stakeholders of the supply chain. In addition, there is a need to develop theoretical basis for the supply chain risk management concerning especially the critical industries.

Compared with many other threats affecting transports, such as accidents, natural disasters or terrorism, a strike is different as there usually is a warning given beforehand, allowing the companies to make preparations beforehand. How well the chosen mitigation and/or contingency strategy worked was then tested in practise during the strike. As the Finnish stevedore strike was only 16 days long, it mainly caused short-term financial losses for the companies due to the special arrangements required to keep production on-going and to fulfil customer orders. Had there not been a warning about the strike, or had the strike lasted a longer period, e.g. a month, or involved also land transport, several companies would have faced serious trouble and companies in the process industries could have been forced to shut down production within a few days. For all companies regardless of industry the strike was thus a concrete learning experience for the importance of mitigation strategies and business continuity planning: it made them re-think their preparedness towards transport disruptions. Many companies realized they need to adapt their long-term countermeasures against such events and risks in general.

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