

RISK AND THE RESILIENT SUPPLY CHAIN*

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Abstract. *The subject of the paper are different understandings of the term supply chain as well as various events that increase the risk of affecting its vulnerability and cause its disruption. The paper is based on findings from a number of important academic papers and research based on the Internet. The aim of this study is to analyze the business implications of periodic disturbances on the companies and their supply chains and to present options to increase the resilience of supply chains in order to reduce their vulnerability to all kinds of potential threats.*

Key Words: *supply chain, risk, resilient, redundancy, flexibility, vulnerability*

INTRODUCTION

Contemporary business conditions and big business pressures such as lack of resources, increasing the number and strength of competitors, globalization of markets, frequent changes, and big expectations of consumers, led to concentration and improvement of operational efficiency in the supply chain. Christopher Martin, the creator of the concept of marketing logistics, said "that in today's environment, supply chains compete, not individual companies". Globalization has offered tremendous opportunities as well as increased risk in the development and the functioning of the supply chain. Very successful supply chains, such as Nokia's supply chain and Zara, are examples of full advantages of globalization. In contrast, several supply chains have found themselves unprepared for the increased risks that have accompanied globalization. Thus, managers must take into account both opportunities and risks that globalization generates long-term when designing a global supply chain network.

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Modern global supply chains are subject to more risks than localized supply chains in the past. According to the research of consulting firm Accenture in 2006, over 50 percent of executives surveyed felt that the risk of supply chains had increased as a result of their globalization of business operations. Based on the aforementioned research, consulting company Accenture has identified sources of risk in global supply chains. Over one third of respondents were indicated by each of natural disasters, volatility of fuel prices, and performance of supply chain partners [see more in 9, 24-30].

The vulnerability causes a serious business risk and disruptions which are threats to many companies. As supply chains become more complex, as well as result of increasing global supply, the companies and their ongoing efforts to reduce losses increase the risk of their functioning. Nowadays, risk management is the challenge for companies who create awareness about the risk of disruptions of the supply chain and allocate resources to the internal processes as to their suppliers and customers. Also, they must identify sources of risk to global supply chains, to consider strategies for reducing the risk. Better management and control internal processes together with more open information flows within and between members of the supply chain can increase its resilience.

However, managers must be aware of the fact that the resilient supply chains just can not predict and many risks can be a cause of their disruption.

Until recently the term supply chain was not widely used beyond academia, associations of specialists from different industries and communities of professional managers. When supply chain disruptions have made serious economic consequences, the term has entered the everyday vocabulary of managers, politicians, researchers and the general public.

2. THE UNDERSTANDINGS OF THE VARIOUS TERMS SUPPLY CHAIN

Supply chain management as a concept and applied scientific methodology is relatively new to the lexicon of management. It was first used in the early 1980s for the emerging discipline of management [13]. This discipline was a response to changes in the prevailing trends in business strategy, which implied that the interests of the individual functions of the higher interests of the subordinate - a more efficient organization, creating and providing better value to customers and shareholders. This resulted in a redefinition and amalgamation of existing business activities, particularly logistics (integrated transport, warehousing and distribution) and management of manufacturing operations. Managing production operations included elements of procurement, inventory management and orders, production planning and control, and customer service.

During the 1990s, in an age of re-engineering of business processes, supply chain management was focused on accelerating the flow of goods and services by expanding the integration of elements of logistics, production management and marketing processes across functions and organizations. The goal of supply chain management was to improve the efficiency of raw material flows of production and flow of finished products to end consumers. Achieving the goal was increasingly enabled by rapid development in information technologies, which in turn opened the way for further improving efficiency and increasing awareness of the changing global market and the emergence of new and unpredictable consumer demands.

In terms of bias functions within the organization and changing perspectives of specialized companies, the term supply chain continues to have different meanings to different people. It is still often used to describe the management activities or integrated production and / or logistics activities within a company. It is also very often used (particularly in procurement) to describe the management and performance monitoring of a company's supplier base, through quality improvement initiatives, involvement in new product introductions, promotions and participation in reducing the overall cost.

From the perspective of modern business, it deserves the highest respect for the complex (end-to-end) access products and related flows of information from sources of raw materials through product delivery to the end consumer and when necessary their reverse flow. Therefore, the supply chain should be understood as "the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce in the form of products and services in the hands of the ultimate consumer." [4]. On the contrary, in today's uncertain markets, supply chains are not simply linear entities or processes: they are complex networks. The product and information flows take place within and between participants (nodes) in a variety of networks that connect organizations, industries and economies .

Modern supply chains are in fact dynamic networks of interconnected companies and industries [5, 187-200]. "No organization is an island and even the most carefully controlled processes are still only good as the good links and nodes that support them" [14, 412-419]. Obviously, everything depends on efficient and reliable transportation and communication systems, but it is often overlooked [4, Peck].

In defining the term "resilient supply chain" in this paper we have veered away from ardently disputed definitions and focused where possible to align ourselves with definitions found in dictionaries and widely accepted. Also, it is very important to avoid some of the potential pit-falls of synonyms. For example, the terms *robustness* and *resilience* are often used interchangeably, but in the context of the supply chain they can have completely different meanings. Generally, the term "robust means that something is a solid construction and strong physical appearance. In the IT industry *robustness* is "the ability of computer system to cope with errors during the execution" [3, 4]. When this term refers to the supply chain, then it shows that it is such a supply chain that is able to cope with the disruptions with minimal losses. However, when a supply chain is robust that does not mean that it is also resilient. In this paper we use the term resilient relating to the supply chain as a networks, so we adopted a definition that is rooted in the science of ecosystems. The system is said to be resilient if it can "return to their original state or to move into a new, more desirable, state after being disturbed" [3, p. 4]. Analogous to this definition, the term resilient supply chain should include its resilience. Since the resilience of the supply chain is a complex phenomenon, we chose to analyze important dimensions – *redundancy*¹, *flexibility* and *corporate culture* [26, p. 3]. Resilience of the supply chain can significantly reduce its vulnerability to different types of risk.

¹ Creating a reserve i.e duplication of critical system's components in order to maximize reliability and ensure its survival

3. THE RISKS OF THE SUPPLY CHAIN - SUCH AS DELL AND LAND ROVER

The term risk is potentially the most problematic to define. In the academic literature there are different interpretations of the term. Among the most common cited definitions based on the variances that were taken from classical decision theory, where the risk involves "a variation of distribution of possible outcomes, their likelihoods and their subjective values [3, p. 5]." Risk is defined as "the probability (of a given event) x Severity (negative business impact), "[11, pp. 1404-1418]. In this paper, the term risk is inherent to any vulnerability of the supply chain i.e. the probability that it is lost or damaged. [3, p. 5]

The risks in the supply chain can be classified in many different ways and from different perspectives: Helen Peck and Martin Christopher based upon a framework originally categorising risk by Mason Jones & Tovill [12, 17-22], suggest three categories of risk that can be further sub-divided to produce a total of five categories: - Internal to the firm (Process, Control), External to the firm but internal to the network supply chain (Demand, Supply) and External to the network (Environmental). [see more in 9-13].

Generally, internal and external supply chain risks are used. In this paper, we would not go into this issue but we suggest it might be a reference for a more detailed study of supply and sources of risk in the supply chain [2, pp. 160-167].

Increased integration in logistics and in supply chain leads to the emergence of new categories of risk. The expansion of risk management within the supply chain can contribute to understanding the key factors of its risks and to enable partners to optimize their internal risk management system. In recent years, the literature emphasizes the practical perspective of risk management and that it is a tool for planning activities and supply chain processes.

The growth in complexity of supply chains and increasing company's dependence on their chains at the same time are increasing risks of their disruptions. In the book "*The Resilient Enterprise, Overcoming Vulnerability for Competitive Advantage*" [25, pp. 12-15.] prof. Yossi Sheff gives a detailed illustration of the complexity of the supply chain that was used by Dell from 2000 to 2005 for the purchase of Intel Pentium processors which are built into their computers. The creation process started in Japan, where the crystal by Toshiba Ceramics monocrystalline silicon transformed into ingot (silicon electronic orders). The ingots are cut into individual wafers and then packed onto planes and sent to one of Intel's factories for the production of semiconductors in Arizona or Oregon. In these factories, wafers are reworked and then re-shipped to Intel's assembly plant and tested in Malaysia. Here the wafers are reworked and sent to ceramic packaging. Thus, packaged products are shipped across the Pacific back to Intel's warehousing in Arizona. When it was necessary "packaged wafers are shipped to Dell factories in Texas, Tennessee, Ireland, Brazil, Malaysia and China, or one of its contract manufacturers in Taiwan, only to be used as components for computers [25]". Dell's supply chain is finished when they deliver products to customers around the world [25]. The question is "why was it at risk"? The key reason was that it was spread over three continents.

The participation of the most dominate markets - China, India, Eastern Europe and Brazil in global supply products and services is rising (Fig. 1). Such changes in the location of sources of supply in the world generate new opportunities and risks for global companies and their supply chains. Also, increasing the need for penetrating into the mentioned markets, creates the problem of more acute disruption of supply chains [10].

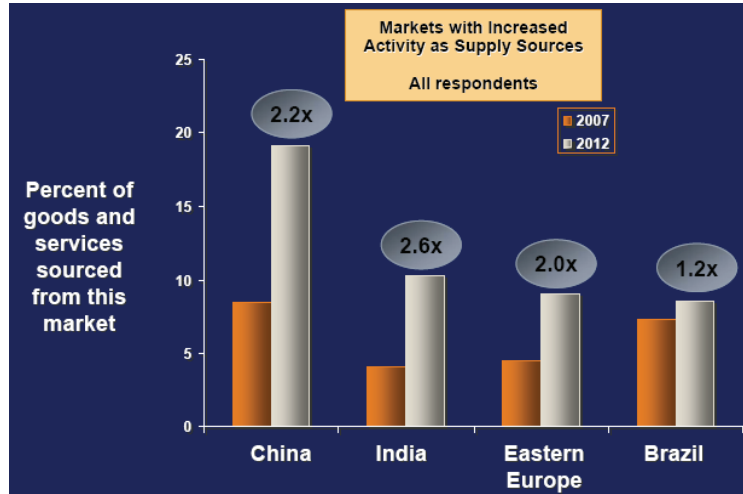


Fig. 1. Share of countries in the global supply of products and services in 2007 and 2012
 Source: A.T. Kearney and Institute for Supply Management TM (ISM) Sustainability Management Survey, January 2007

A wider range of sources of risk for the operation of global companies can be seen from the Figure 2. Due to the complex nature of modern supply chains, just about every disruption can very adversely affect the business activities of globally oriented companies. As the complexity of supply chains is rising and as world trade and business are becoming more uncertain - due to increased risks from terrorism, climate change, political change etc. the number of companies which are adopting strategic action plans in the event of disruption of their supply chains is increasing.

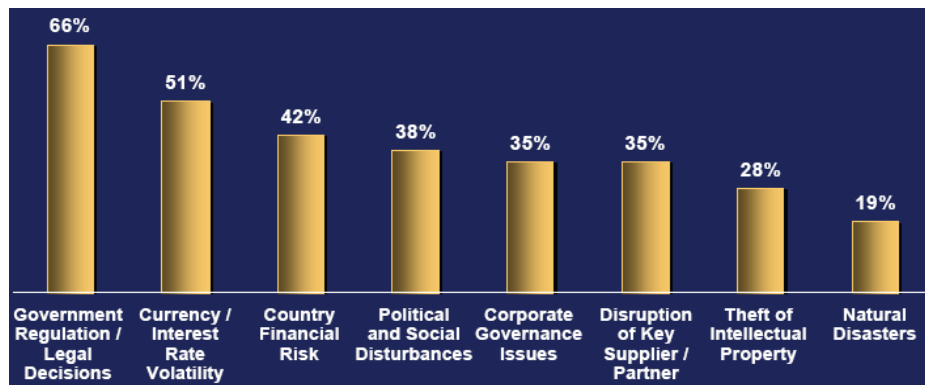


Fig. 2. The greatest risks to the operations of global companies
 Source: A.T. Kearney Foreign Direct Investment Confidence Index, 2005

When operating successfully, modern supply chains enable production and delivery of products in the right quantities, at the right place at the right time and cost efficiently.

Respecting the nature of the network chain and its stages, it can be concluded that companies operation keep track of risks.

The risk a company can generate to its supply chain but also the risk a supply chain can generate to a company as a stage in supply chain. It is well known that in January 2002, the risk of a supply chain company Land Rover² [21, 20], which at that time was a subsidiary of Ford, was caused by the largest supplier of chassis - UPF-Thompson. Namely, at the end of 2001 the company UPF-Thompson of Wolverhampton, a city in the West Midlands region - Central England, became illiquid which caused a risk on its key customer Land Rover which was sudden and unfavorable. Land Rover was completely unprepared for UPF-Thompson company's bankruptcy which was the sole supplier of chassis for the company's best-selling Land Rover - Discovery. The auditors of the company UPF-Thompson Mark Orton, Myles Halley and Roger Oldfield from the global auditing firm KPMG³, have threatened to stop delivery unless Land Rover made immediate up-front payment between 35 and 40 million pounds. This action representatives from the global auditing firm KPMG followed the decision of The Great Britain to allow them to choose another supplier and meet creditors' demands because of the inability of Land Rover. Land Rover had to pay off the debt of the company UPF-Thompson, which allowed them to continue to supply them with chassis.

Thus, inadequate monitoring of its main suppliers of chassis-UPF - Thompson, almost cost the company Land Rover its survival. However, a temporary measure prevented it. This measure enabled the Land Rover to find another supplier who will take over the UPF - Thompson's business. This has prevented the release of 1400 workers employed in Land Rover but also in other companies within the networks of its suppliers. Therefore, supply chain company Land Rover has come into a danger of collapsing because of its suppliers - UPF - Thompson. De facto, the collapse of the UPF-Thompson has directly contributed to the problems between them and their customers in the automotive industry for the failure of the German branch Meckenstock and the enormous costs of an American unit in the provision of new truck parts for General Motors. It is logical to conclude therefore that the Land Rover deeper partnership with a UPF-Thompson probably warned managers with Land Rover about the crisis before it happened.

The contract with Land Rover has made up about 65% of the UPF - Thompson company's business. Apart from that, it was thought that this contract is damaging the company UPF - Thompson. According to some estimates, in the beginning of 2002, the illiquidity of UPF - Thompson could threaten more than 200 small business firms in the West Midlands region by supplying Land Rover. About 10,000 people could lose their jobs and it would take 6-9 months to reach an agreement with a new supplier.

² Land Rover has changed several owners. In the 1980s British Leyland was broken up and in 1988 Rover Group, including Land Rover, was acquired by British Aerospace. The company became part of the Leyland Motor Corporation in 1967. In 1968 Leyland Motor Corporation itself merged with British Motor Holdings to form British Leyland. Rover Group, including Land Rover, was taken over by British Aerospace in 1988. In 1994 Rover Group was acquired by BMW. In 2000 Rover Group was broken up by BMW and Land Rover bought Ford Motor Company, becoming part of its Premier Automotive Group. From 2nd June 2008 The Land Rover, along with Jaguar and Lanchester, is by Indian company Tata Motors, (www.reuters.com/article/2008/06/02/us-tata-jaguar-idUSBMA00084220080602 - Accessed September 7th 2011.).

³ KPMG is a global network of professional firms that provide audit, tax and advisory services. It employs about 138,000 professionals who provide services in 150 countries worldwide

4. THE RESILIENT GLOBAL COMPANIES AND SUPPLY CHAINS - A SINE QUA NON TO REDUCE THEIR VULNERABILITY

The infinite range of potential disruptions that can negatively affect companies and their supply chains often does not manifest itself (high impact/low probability - HILP). Such HILP events can be classified as follows: a random phenomenon, such as hurricanes, floods, earthquakes, accidents of all kinds, such as spills from the tanker Exxon Valdez⁴ [23, 24, 15], the eruption of oil from the seabed due to rupture and explosion of oil rig Deepwater Horizon, the Chernobyl nuclear disaster, nuclear disaster and Bopal disaster⁵ in Fukushima, deliberate distortions, which include not only terrorist attacks but also sabotage (eg pipelines in Niger and Iraq, 2008).

The solution for the primary disruption may generate other disruptions. For example, when the UK closed the rural areas to cope with foot and mouth disease in 2001, it suffered more damage from a reduction in tourism than the actual impact of the disease on agriculture.

HILP disruptions often cause fear in the public – e.g, the events on September 11th 2001, anthrax and foot and mouth disease (Foot and Mouth Disease - FMD). The same goes for hurricanes. Apart from destroying 64 oil platforms, Hurricane Katrina in 2005 also caused the temporary evacuation of more than 400,000 residents of New Orleans. Fear can lead to the accumulation of resources, for example. Fuel shortages at the time, of antibiotics and the fear of the spread of anthrax. This fear can lead to excessive government reaction, which is aggravated disruption caused by the need to restore public confidence. For example, during 2009, many European countries which were scared of expanding of the influenza virus H1N1, overreacted by purchasing large amounts of vaccine. Some of them (e.g. France, the Netherlands and Switzerland) were able to sell their surplus vaccine while the other countries (e.g. Germany and Spain) returned those which had been bought to the vaccine manufacturers. As a consequence of excessive fear and decline in value of shares of vaccine manufacturers in 2010, Governments of some countries in Europe have launched a local investigation for fraud in the choice of vaccine manufacturers, while others have accused the World Health Organization and other health organizations for corruption involving, apart from World Health Organization, some drug companies and scientists.

⁴ The Deepwater Horizon was the largest oil environmental disaster in American history (see: www.usatoday.com/news/nation/2010-05-27-oil-spill-news_N.htm?csp=34news), Accessed 2011-09-12, which is well beyond the catastrophic oil spills (between 41,000 and 119,000 m³) of oil tanker Exxon Valdez 1989. in Alaska. The cause of the eruption of oil from the seabed was a result of the explosion of oil platform Deepwater Horizon on 20th April 2010 in the Atlantic Ocean, close to of the State of Louisiana. The platform belonged to the company Transocean Ltd. , headquartered in Geneva, and was chartered by British Petroleum Corporation. Estimates of the amount of oil thrown in the sea date back between 500,000 and 1,000,000 tons (see www.zeit.de/news-nt/2010/7/16/iptc-bdt-20100716-428-25600522xml). As a result, the sea surface of about 9.9000 km² was polluted (see www.focus.de/panorama/vermishtes/deepwater-horizon-oelteppich-wird-immer-groesser_aid_504318.html, Accessed 2011-09-12). The biggest victims of disaster are fishing, tourism, marine flora and fauna and various kinds of birds.

⁵ Bhopal disaster occurred in December 1984 in an Indian city. In a factory for the production of U.S. concern pesticides Union Carbide in India there was a technical failure and leakage of toxic gas **Methyl isocyanate** into the atmosphere. About four thousand people died as a result of gas poisoning and thousands more became permanently sick from inhaling toxic gas. It is the largest chemical disaster in the world recorded so far.

To avoid, or to successfully recover from HILP disruptions, companies need to implement measures to improve their own resilience. It is also important to recognize the characteristics that distinguish the disruption from normal HILP disruptions.

Notwithstanding the constant increase in the number of scientific publications on companies' resilience and their supply chain, this management area has not yet been fully explored. It is certain that the term resilience has been taken from the engineering and it means that material has the ability to return to its original form after deformation. The term is viewed from the standpoint of companies indicating their ability and the speed with which they can turn their performance (i. e. manufacturing, services and supplies) to normal levels after HILP disruptions. Resilience of the companies can be achieved either through redundancy or through flexibility. Redundancy involves creating a safety inventory for materials and finished products. Such inventory can increase the flexibility of the company i.e. give it enough time to plan its recovery after disruption

Similarly, resilient supply chain is one that is able to recover from the disruption while the flexible supply chain that is able to respond to daily changes in demand.

Any disruption should be used as a defense from it and to adapt to the situation. Data concerning natural phenomena are available and can be used in making decisions about facility location and redundancy measures - health insurance rates, which are based on these data, can be used to manage risk⁶. After many years of research, leading companies have identified the causes and consequences of disruptions and the introduction of security processes and protective measures has reduced their number greatly. However, deliberate disruptions can be controlled to some extent - the threat can be controlled depending on the level of defensive measures. Therefore, the probability of the occurrence of a disruption is a function of security measures taken and resilience. To successfully reduce the probability of induced disruption, the companies have implemented security measures - by investing in methods that reduce their vulnerability. Of course, the company is part of their supply chain and as such it represents a vulnerability to the chain and it should be noted.

Certain adaptations can be applied in the supply chain by security principles which for many years have been applied in the national defense and intelligence services. Layered and balanced methods should be combined with other joint efforts, including partnerships between public and private sector, creating a consortium with participants from different industries and implementation of programs involving employees; all this will result in safety culture.

Among the measures that contribute to the redundancy of the supply chain is the one that includes the expected increase in inventories due to the disruption. For example, NUMMI⁷ [7, 8] has accumulated additional quantities of parts when in the spring and

⁶ We often face four types of redundancy: 1) hardware redundancy (e.g. DMR machine - a machine that works with double TMR elements and situations in programming where the three systems carry out a process when a system error after the other two corrects this mistake), 2) redundancy of information (e.g. methods of detection and correction of errors), 3) time redundancy (e.g. alternative logic), and 4) software redundancy (e.g. N-version programming).

⁷ New United Motor Manufacturing, Inc. (NUMMI) is a joint venture of General Motors and Toyota in manufacturing and selling cars under the brand of both companies, from Fremont, California. Founded in 1984 and ceased to be operational in 2010. On October 27, 2010 it reopened as a 100% Tesla Motors-owned production facility, known as the Tesla Factory. <http://en.wikipedia.org/wiki/NUMMI>, Accessed September 10th 2011. [<http://www.bizjournals.com/sanjose/news/2010/10/27/tesla-officially-replaces-nummi.html>]of Tesla Factory, Accessed September 10th 2011.

summer of 2002 occurred deterioration of relations between employers and employees as well as adverse political decisions and regulations that govern them in the West Bank, which led to the closure of ports on the East Coast. However, additional quantities of inventory are causing much costs. In addition, as demonstrated by lean and six sigma processes, it can also lead to sloppy operations that result in increased costs and reduced quality. By contrast, increasing flexibility in the supply chain can help companies not only to withstand HILP disruptions, but also to respond better to the daily whims of the market. In order to build flexibility, companies must: a) enable the transfer of production between plants, b) use interchangeable and generic parts in many products, c) train employees to do more tasks, d) use similar processes for product development, e) increase the production of products to meet the increased demand (ramp up)⁸, [22] f) design products which enable the maximum postponement for more operations in the supply chain, and g) align their procurement strategies with their suppliers.

Companies which have already designed their supply chains in order to respond to demand fluctuations have also built the ability to respond to the problems in supply. How to influence the increase of the resilience of the supply chain? Postponement, which means postponing final product configurations in the supply chain until you obtain precise information about demand and built-to-order operations (production based on orders) allows redirecting the flow of parts, semi-finished and finished products from the area in which there are too many into the areas where there are not enough.

Dell responded more effectively to customers than Apple immediately after the earthquake in Taiwan in 1999, which interrupted the production and global purchasing of memory chips for two weeks. Using a small number of parts by company, not only have they simplified production and reduced procurement costs, but also have created flexibility in terms of switching to other suppliers if one of them fails. When Intel's Systems Group has reduced the mix of 2,000 different types of resistors, capacitors and diodes to only 35 species, not only has it simplified the procurement and reduced costs but it has also increased its ability to respond when demand showed some variability and disruptions in supply.

So, the problem which was created by the earthquake in Taiwan could not be resolved through alternative forms of transport or various sources of supply. Company Apple has faced a shortage of semiconductors and other components and due to it postponed the production of its iBook and Power Macintosh G4 desktop computer at a time when their demand was growing. Apple has been unable to change the configuration of the product, but decided to deliver slower G4 computers than were ordered by customers, so the company has received many complaints. Dell has done much better. Although Dell's model of

⁸ The situation when a company increases the production of products prior to the anticipated increase in demand for them. Increase in production commonly occurs when a company enters into an agreement with a distributor, retail dealer or other firm, because then there is a significant increase in demand for its products. For example, representatives of the joint venture of Toyota Motor with the Chinese company Guangzhou Automobile as of June 2008 announced it would invest 380 million dollars in the construction of new production lines in Guangdong province, that is, the "enhanced" production of the Camry sedan (see www.spacemart.com/reports/Toyota_says_to_ramp_up_production_in_China_999.html- Accessed 17.02.2011.) in order for them to meet the growing demand in China. After the announcement in 2008 The Guangzhou Toyota Motor Company began building a second production line at its factory in Guangdong Province with annual capacity of 120,000 Camry sedan in 2009.

direct sales allowed to hold inventory for only 5 days, it was able to continue selling and delivering products. Dell has used incentives based on price and promotions, which were customization on their online choiceboard. Choiceboard is a tool based on the web that allows real-time two-way interaction between Dell and its customers. This tool was the basis of build-to-order and known as Dynamic Value Chain Management (DVCM) of Dell system. DVCM system has allowed minimization of loss of cash, debts and inventories. It was probably the most efficient distribution system in the world. [6, 216] Customers are able to choose on the site exactly the products and services they want - including attributes, components, prices and delivery options - and then forward the Dell all-in order fulfillment. So choiceboard not only allowed a wider choice but rather a clever source. Dell was using a choiceboard-influenced to consumer choice and was balancing supply and demand. Despite the disruptions in its supply chain, Dell's revenues in the third quarter of the 1999 increased by 41% compared to 1998 [17].

Shortening the time that elapses from product design to its appearance on the market also means that the recovery time of the disruption is likely to be shorter. Thus, Lucent created a special network organizations for supplying in 2001. Going beyond the company's departments for engineering, procurement, manufacturing, distribution and even sales, the network has increased the agility of the company.

By using many suppliers with different characteristics, HP has become both redundant and flexible. How has the company chosen factories to supply its divisions for printer production? While the printers were increasing production in order to meet increased demand (ramp-up) and at the end of their life cycle (end-of-life), HP has used its agile ⁹[18], but more expensive, factory. However, during the period of stable demand for printers, it used a more efficient but more expensive factory .

The company's close relationships with suppliers are an important component of its resilience. The company may retain close relationships with several key suppliers, or superficial relationships with many suppliers. In any case, company should have some knowledge of its trading partners and thus be informed of potential disruptions in advance. The relationships of collaboration with business partners can help companies reach the market faster. Solid business relationships with dozens of suppliers enabled the company Toyota to recover quickly from the fire that in February 1997 broke out in the factory, destroying its main suppliers of P-valves. Disruption, which was the earthquake in Japan in March 2011, caused the delivery of auto parts initially hit the production capacity of Toyota on its international markets, particularly in Asia. The earthquake destroyed a particular supplier of Toyota production from the northeast of Japan. However, as early as July 2011 the production of many of these suppliers has reached the level before the earthquake [16]. Representatives of the Toyota production point out that production recovered two months before the expected date, thanks to the continued recovery of the production of its suppliers as well as strong collaboration with them.

By creating interchangeable components or even production facilities, the company diversifies the risk in case of unexpected interruption of its supply chain. For example,

⁹ Agile - be capable to responde adequately to the changes. In the early 1990s the term agile manufacturing meant creating an organization whose processes, tools and training carried out to enable quick response to consumer needs and market changes to control costs and quality. More at: www.jocaonstuff.com/2011/05/the-agile-company, Accessed June 13th 2011.

Intel takes into account the flexibility of production capacity, i.e. the possibility of moving its production from one factory to another, if necessary. It can be extremely effective in an emergency situation. Intel is able to avoid loss of production moving from one production to another plant, which can provide an effective response to changing global demand patterns.

In order to market disruptions after the company successfully recovered, they must be flexible and not only redundant but also to develop good corporate culture. For example, at the first glance, organizations such as Dell and the Navy do not have much in common. However, looking closer, these companies' resilience share several common features, particularly within their corporate culture. These organizations authorize people to act when they discover a problem. For example, in the U.S. Navy, the lowest ranking sailor can completely stop the take-off of aircraft carriers. If a sailor sees the problem during the takeoff, he is authorized to immediately seek to stop the flight. This rapid action allows the organization to take corrective action as soon as possible, increasing the chance of successful action in an emergency.

An important feature of the resilient organization is its ability to change bad news and to devote quickly to the root causes. A good example are the mobile phone manufacturers Nokia and Eriksson. Fire in the factory of their main suppliers stopped supplying them with a chip which was essential for their production. Nokia's open culture has enabled the spread of news, and they quickly recovered by finding other sources. In contrast, the company Eriksson was more closed, and covered up bad news. The result is as follows: by the time the company realized that Eriksson is in deep trouble, Nokia had bought up most of the alternative sources of chips. Later the company Eriksson left the market.

Unfortunately, the corporate culture is difficult to define and even harder to change, but it is not an impossible task. Success in improving quality in the 1980s and campaigns on safety at the beginning of the last century show that the corporate culture can be changed. A good example of corporate culture change in the company Continental Airlines. Under the leadership of Gordon Bethune the company has gone from the company with the worst success in 1994 to one of the best companies in 2001. Gordon Bethune in 1995 created the plan Go-Forward in order to solve problems in company. The plan included, among other things, employee morale, product quality and structure of the route. The role of Gordon Bethune in the company Continental Airlines between 1995 and 2001 was primarily in the introduction of a new vision of the company in corporate culture, and translating that vision into unbelieving employees. When his vision of a future was so presented that it was acceptable for employees, they were able to carry out the unpleasant but necessary changes relating to the reorganization of work and responsibilities in this company [1].

Even the culture of the population may change, as evidenced by campaigns against smoking and driving under the influence of alcohol in some European Union countries. These success stories should serve as examples to other companies that seek to be resilient, because culture means that the entire organization must be committed to corporate security and can take the necessary measures to recover from any disruption, when the normal hierarchy does not work.

The cost of investments in the resilience must be justified, and companies should be aware of common errors in assessing feasibility. It is often assumed that companies can justify the assessment of costs and disruption assertion and that these costs can be avoided

if the organization is preparing for a crisis. This approach is not convincing, because the cost of investing in the resilience of the true cost until the potential costs that are avoided does not appear in the income statement or balance sheet. However, most investment in resilience carries collateral benefits or benefits that are by-product resilient. The biggest benefit is that the company is more responsive to market changes, eliminating the need to justify such investments solely on the basis of cost evaded.

Assessing the level of required investments is easier when you know how much the company is vulnerable to disruption. The two most important issues in dealing with potential disturbances are: 1) What is the probability that the incident will happen? and 2) What can serious consequences be if an incident occurs? The introduction of various disturbances on the graph with two axes - one that measures the probability of the event and another that shows its expected weight - can help companies to determine the priority of potential disruptions and prepare answers to these disruptions.

CONCLUSION

The world is becoming riskier. Natural disasters, disputes between the industries, diseases, crime, terrorism, local wars and similar disruptions put to the fore the unpredictability and changeability of environment. In this environment the risk of disruption of the supply chain increases. Given that one disruption can cause various effects, functioning of supply chains in the usual way is often not an option. The effects of supply chain management are increasingly determining the effects of risk management of their termination. Enough experience to prove that are Dell and Land Rover.

Supply Chain Managers' ideal state is more difficult - fully integrated, efficient and effective supply chains, which can create and maintain competitive advantage. To achieve this, managers must balance the demands to reduce costs and increase efficiency, to identify the demand for services and to learn about the risks of failure caused by operation of supply chains.

The existence of companies increasingly depends on the level of the plan for identifying and managing risk in their supply chain as well as measures to improve their resilience. Resilience of the supply chain strategy, whose focus is to reduce the probability and/or mitigate the impact of disruption in the supply chain to its function, significantly depends on the successful identification, assessment and drawing up a priority list of causes / sources of potential disruption.

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RIZIK I ADAPTIBILNOST LANCA SNABDEVANJA

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Predmet istraživanja u radu su različita shvatanja termina lanac snabdevanja kao i različiti događaji koji su povećali rizik koji utiče na njegovu ranjivost i izazivaju njegove prekide. Rad je zasnovan na saznanjima iz izvesnog broja važnih akademskih radova kao i na istraživanjima na osnovu Interneta. Cilj rada je da se analiziraju poslovne implikacije povremenih poremećaja na kompanije i njihove lance snabdevanja kao i da se prezentiraju mogućnosti za povećanje adaptibilnosti lanaca snabdevanja kako bi se smanjila njihova ranjivost na sve vrste potencijalnih pretnji.

Ključne reči: lanac snabdevanja, rizik, adaptibilnost, redundantnost, fleskibilnost, ranjivost.