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PO Box 117
221 00 Lund
+46 46-222 00 00



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Paulsson Ulf



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Disruption risk, Domino effects, Flow-based society, Managing disruption risks, Supply chain, Supply chain security, Supply chain risk, Supply chain risk management, Risk handling, Risk management, Vulnerability.

Abstract

This report presents a meticulous review of the background of today's flow-based society and its vulnerability. Furthermore, there is a discussion about how to define flow-based disruption risks, and how their consequences, including the domino effects, can be described. Also the theory areas, addressing this kind of risks, are treated in this report.

The modern society of today is, to a great extent, built up round supply chains. In these strictly integrated chains, with a number of often globally dispersed links, there is a constant flow of physical goods, services and also combinations of goods and services. A disruption within any of these flows may very well lead to far-reaching negative consequences, not only for the private company but also for the society in general.

The private company's (or organization's) supply chain and its surrounding environment is exposed to constant changes, which affects its risk picture. It may be difficult to completely avoid being affected by disruptions and disturbances, and perhaps not even desirable, considering the high risk handling costs this probably would require. On the other hand, it is important not to be affected unnecessarily hard, since this of course means a waste of resources. In competitive business activities it is especially important not to suffer worse than the competitors; preferably you should be less affected. Efficient risk management can thus provide a vital competitive advantage.

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ABOUT THE AUTHOR

Ulf Paulsson is a retired Senior Lecturer at School of Economics, University of Lund, and also a Doctor of Philosophy (PhD). He has many years' experience of research, teaching and tutoring in the fields of Logistics and Supply chain management. During the last decade, more and more focus has been targeted at the disruption risks of the flows (Supply Chain Risk Management) and Paulsson has written a doctoral thesis and several research reports in this field.

1 OUR VULNERABLE FLOWS

On February 26, 2011, the Landvetter airport was completely shut down and the terminal was evacuated for more than 2 hours. 30 flights were cancelled and about 2 100 travellers were affected one way or another, because a man with a suspicious bag had been stopped at the security check. When the police bomb experts examined the bag closer, it turned out that the contents were harmless.

On March 31, 2012, there was an explosion in the factory of Evonik Electronics AG in Hanau-Wolfgang in Germany. About half of the car industry's need for the synthetic resin PA-123, which is used as a component in the fuel- and brake systems of modern cars, was manufactured in the factory. The explosion threatened to stop parts of the car production in the world, why representatives of a large number of car manufacturers assembled for an emergency meeting.

On July 30 2012, big parts of the Indian electricity supply network collapsed and about 600 million Indians were without electricity. It started with an overload in northern India but since the different power systems were interconnected and also, in many cases, undersized, the effects of the short circuit spread to about half of the Indian population.

In 2010 Toyota was the biggest car manufacturer in the world, measured in the number of produced vehicles. In 2011 the company only finished in third place. This was explained by large-scale disruptions for Toyota during 2011: partly from repercussions from the Fukushima disaster in Japan, partly from extensive flooding in northern Thailand.

The above-mentioned are just some short examples of disruptions in the flows and their sometimes very large-scale, destructive consequences. In many respects we have created a vulnerable society. This has not been a deliberate ambition, but is a consequence of the fact that today's society, to a large extent, has been built up round *supply chains*. In these strictly integrated chains, often with a number of globally dispersed links, there is a constant flow of input goods and services and also of finished products in the shape of physical products, services as well as combinations of physical products and services.

This sort of supply chains will from now on be called *flow chains*. There are also supply chains with other characteristics, as e.g. just one or a limited number of links; big buffers between the various links; local production for local consumption; simple products based on few components and uncomplicated technology; piecewise manufacturing and/or individually adapted products according to the requirements of the individual customer. However, focus in this book is on the flow chains, partly since they tend to be increasingly common, partly since vulnerability problems in this sort of supply chains are the most predominant, especially regarding disruption risks.

2 WINNERS AND LOSERS

There has been a development from a transport- and storage chain, with a number of different links that were relatively decoupled from one another because of, e.g., various buffers such as stocks and generous time margins, to a strictly integrated, specialized and globally spread supply chain. For the end customer/consumer this has resulted in reduced prices, increased availability and better service.

The private individual in his capacity of consumer is definitely a winner. Other winners are the companies that have been able to quickly adapt to the new flow society and have implemented the necessary, often very extensive, restructuring measures that were required to remain competitive. If you have succeeded in this, not only have you survived but often new expansion possibilities have unfolded as well.

Losers are people who have been affected in a negative way by the restructurings. Losers are also the companies and organizations that have failed to adapt to the changed conditions in time. One changed prerequisite is the risks. In many cases the company risk picture looks completely different today, compared to before.

3 FOCUS IN THIS REPORT

3.1 On known risks

The total risks can be divided into known, partly known and unknown risks. From now on, the risks being dealt with in this book are *the known risks*. On every occasion some of the known risks tend to be in focus, i.e. are in the centre of attention, while others are more or less being ignored. There may be several reasons for this, as e.g. that old risks tend to be worn-out, that new risks seem more threatening than they really are, that a recent accident has caught our attention or quite simply that new information about a certain kind of risk has brought it into focus.

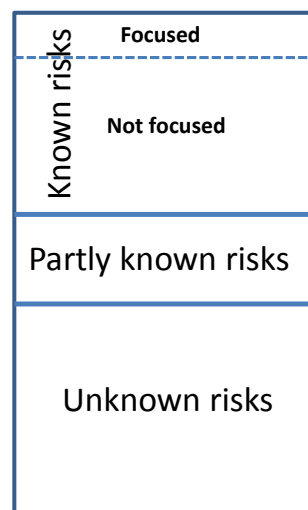


Figure 3.1: The total amount of risks involved.

3.2 On both physical products and services

In the 1990s, when the interest in disruption risk issues really awakened, focus was on physical products. However, gradually throughout the years, we have quite often become aware that also services have been produced in long chains and may be exposed to the same kind of disruption risks as physical products. It is, for instance, obvious that many economic services are linked together in long chains. If there is a disruption in one link, the disruption might rapidly spread to other links, thus resulting in serious economic consequences.

3.3 On the balance between production and protection

It is important to find a suitable balance between the effort to reach an efficient production and the ambition to protect this production. For instance, an increased cost-effectiveness in the production can often be reached by reducing or even by entirely eliminating the buffer stocks; or by changing from several suppliers to just one supplier for the separate input goods. On the

other hand, if there is a disruption, then the negative consequences will probably be more serious. If we want to improve the protection of the production, i.e. make sure that the production continues, we should take the opposite measures, and increase the size of buffer stocks and use more suppliers for the separate input goods, than is the case today.

According to Reason (1997, p. 4), every organization must work with both production- and protection activities. Reason means that too strong efforts to protect the production will lead to increased production costs and reduced profitability or even loss. In the long-term perspective this can result in bankruptcy and/or a phasing out of the business. On the other hand, it is certainly true that a far too one-sided production priority will lead to a short-term increased profitability, but there is also a risk that a disruption might cause so far-reaching consequences that it forces the company into bankruptcy. Therefore, it is important to take a state of equilibrium, i.e. create a suitable balance between production and protection of the production

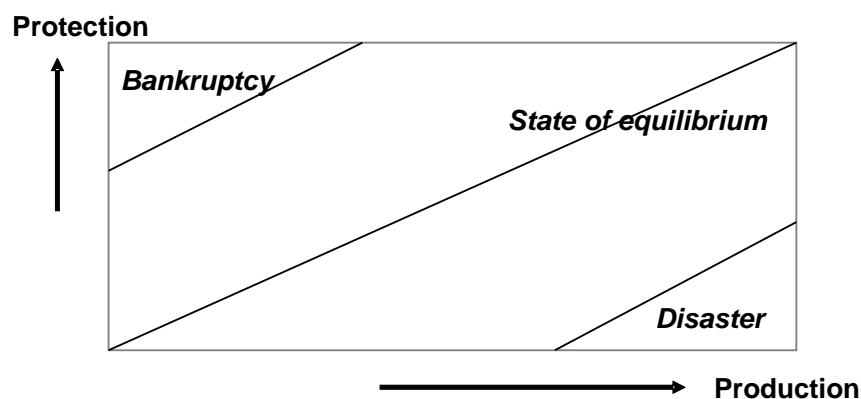


Figure 3.2: The balance between production and the protection of the production (James Reason, 1997, p. 4).

3.4 On the overall efficiency in the flow chain

We often talk about efficiency as if this concept is definite and only has one meaning. This is not the case, since there might be three different kinds of efficiency when discussing flow-related risks: first, the efficiency we reach when everything goes according to plan (going-as-planned efficiency); second, the efficiency you reach when everything goes wrong, i.e. when you are affected by unplanned disruptions and disturbances (going-wrong-efficiency); and third, the overall efficiency which refers to a combination of the two types mentioned above, and with consideration of their likelihood.

In situation A (table 3.1) the economic outcome is +100 when everything is going smoothly as planned and –400 when everything goes wrong. The likelihood for the two alternatives is 95 and 5 per cent respectively. This results in an expected outcome of 75.

Table 3.1: Expected economic outcome for situation A.

Alternatives	Economic outcome	Likelihood	Expected economic outcome
<i>When everything runs smoothly</i>	100	95 %	95
<i>When everything goes wrong</i>	-400	5 %	-20
			<i>Total: 75</i>

Now, suppose the company invests in streamlining the manufacture and that this leads to a ten per cent increase of the economic outcome when everything goes according to plan. At the same time, the negative economic outcome will increase if anything should go wrong by 100 per cent. This new situation is called situation B. If we assume that the likelihood is unchanged, this will result in the outcome below (table 3.2).

Table 3.2: Expected economic outcome for situation B.

Alternatives	Economic outcome	Likelihood	Expected economic outcome
<i>When everything runs smoothly</i>	110	95 %	104,5
<i>When everything goes wrong</i>	-800	5 %	-40
			<i>Total: 64,5</i>

The expected financial outcome is now only 64.5. However, going-as-planned efficiency has increased, and many times you would like to think that total efficiency is the same as going-as-planned efficiency, especially if you have a short time horizon. But for each situation, both alternatives, i.e. when everything runs smoothly and when everything goes wrong are included in the assessment.

4 THE BACKGROUND TO TODAY'S FLOW-BASED SOCIETY

4.1 Our consumption needs

Man needs food and drink, roof over his head and clothes on his body to survive - we need to consume. In addition to basic consumption for daily survival, we can also be consuming for reasons related to non-basic needs. In general, it is said that four utilities are necessary for consumption to take place: time utility, place utility, form utility and possession utility. The different utilities are linked to various activities within the business. The form utility is created through production, the time utility gained through storage, the place utility through transport and the possession utility, finally, through purchases/sales.

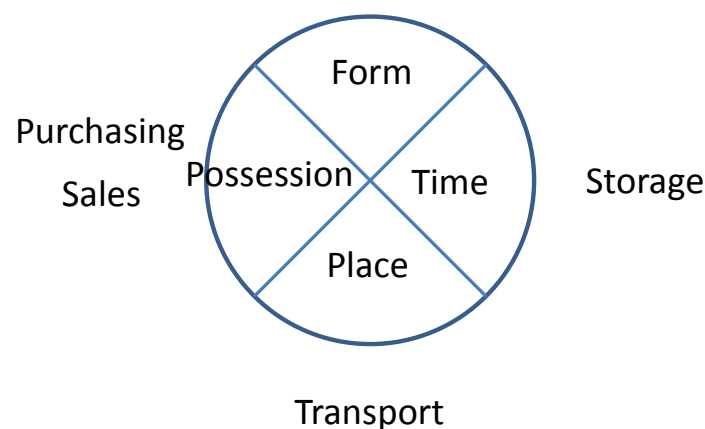


Figure 4.1: The link between utilities and business activities.

4.2 The development of the flow society

4.2.1 The farm

Until the end of the 19th century, the farm in Sweden was the most important economic unit, from a production as well as a consumption point of view, but also regarding transports and storage. Almost everything that the farm's inhabitants consumed was also produced on the farm. The storing took place in direct connection with the production as well as the consumption site. The typical transport distance was only a few hundred metres. Certain trade with other countries, and even with geographically remote countries such as India and China, has existed for a long time. However, the quantities transported were very modest, and transport costs so high that only a very small percentage of the population could afford to buy the goods. Local trade in urban squares and local markets has also existed for a long time, but only a small part of the country's total production and consumption was affected. Self-government dominated.

Land transports of more than 20 km were very rare; long-haul transports were almost always in the form of maritime transport. With few exceptions, people usually did not buy goods that were manufactured far away - perhaps even in another country - and transported here, simply because these goods became too expensive. One exception, however, was the salt, a necessity product used as a preservative.

You yourself produced most of what was consumed: mainly basic products necessary for daily survival e.g. food, utensils and clothes. When necessary, the products were adapted to the individual user's conditions and needs.

Therefore, if the person had a bigger right than left foot, this was not a problem, nor was this the case when someone else, as the local shoemaker, made the shoes. Factory-made goods in standard sizes did not exist yet.

There were no refuse dumps, except in the big cities. Very little was left of what was produced, and almost everything that could not be consumed, such as haulms and peels from vegetables, were recycled in one way or another. In fact, you lived in what we today call a recycling society, even though that concept was not invented at the time.

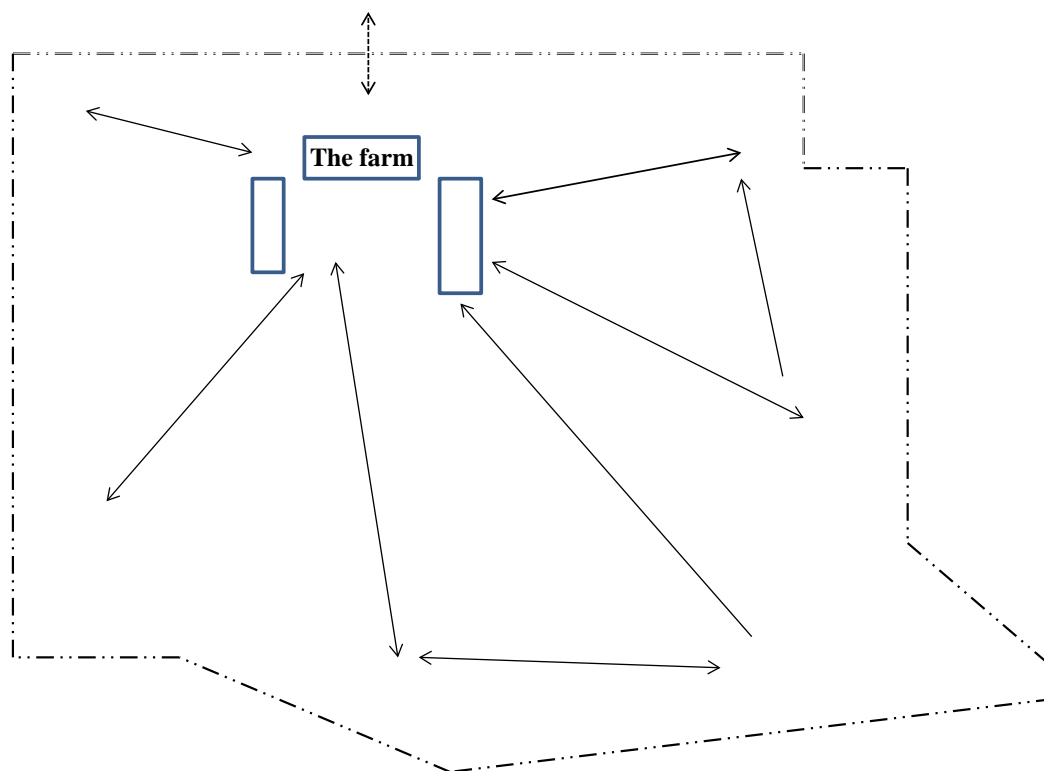


Figure 4.2: "The farm".

4.2.2 The factory

In the 19th century there were still waterborne transports that dominated the non-local transports. Along the coasts sailed a lot of small boats (coastal shipping), which can be said to correspond to today's long-haulers. For inland transport, there were attempts to make use of the water in terms of seas, lakes and rivers in different ways. These possibilities were, of course, geographically limited, and for local land transports horses and wagons were the most common - a rather inefficient mode of transport. Almost all cities were therefore located by water in one form or another.

By the middle of the 19th century, the building and construction of railways started. This meant a strong reduction of the transport costs, compared to the horse and the carriage. Suddenly, you could move a much longer distance with the same transport cost (assuming there were railway tracks). New societies and even cities grew up and developed inside the country where two railway lines happened to cross each other. In the 1900s motorism appeared and the road network expanded and improved significantly, further enhancing accessibility across the country, especially in the inland.

The increased availability meant, among other things, that you could concentrate production to fewer and larger production units. Then you could achieve economies of scale and lower production costs per manufactured unit. As a result, we received a restructuring process that shut down many smaller production units, while others were expanded to increased capacity - a process going on today, but now at a global level.

The dominant production unit now became the private manufacturing company - here called the "*factory*" and no longer "the farm". Production still consisted mainly of basic products for daily life, but also some "non-necessity" products were produced. The factory also manufactured factory-produced standardized products, made in large series. There were still pieces of craft-produced products, but at a higher price than the factory-produced.

The supply chain consisted of a few links, and one of the links contributed most of the total value of the product. Usually, the production was intended for a local market and was directly related to this. As a result, transport and storage were also carried out locally. Although some recycling existed, it was mainly about a one-way supply chain.

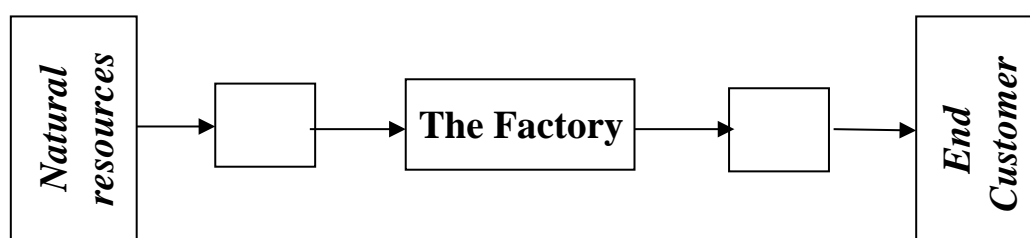


Figure 4.3: "The factory".

4.2.3 The regional supply chain

The supply chain here consisted of a number of links that, however, all tended to exist within the region. One of the links was responsible for the main value adding, and therefore dominated the chain: regional production for a regional market. Also transport and storage usually took place in the region in question. Although the production of non-essential goods increased, it was still primarily the question of producing basic products for daily life. The products consisted mainly of factory-produced, standardized products made in large series. A smaller portion of the craftsmanship products were also available, but at a significantly higher price. Very little recycling existed. It was mainly a one-way supply chain, which tended to end at the local refuse dump.

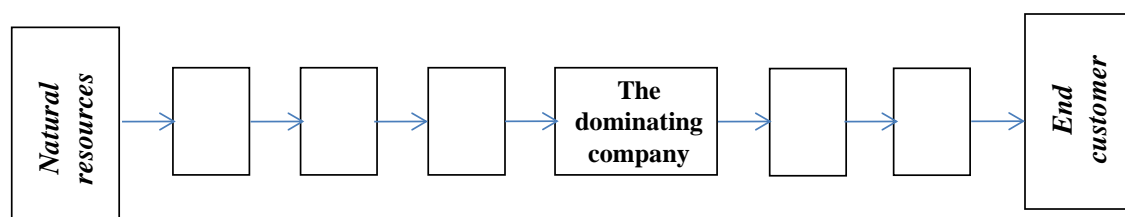


Figure 4.4: "The regional supply chain".

4.2.4 The global flow chain

After the Second World War, the borders between the countries were opened again. But it was usually difficult, expensive and time-consuming for the goods to cross a border. Different political processes and decisions, however, helped to gradually open up more borders, which meant that they could be crossed for only a short period of time or even without a break, at low cost and with a minimum of paperwork.

The rapid technological development made the means of transport more efficient, and the cost per tonne-km fell steadily, which meant that the company could have its suppliers as well as its customers geographically farther away.

Reloading costs also fell rapidly. In the case of full manual handling, the transshipment costs were about the same, wherever you reloaded. However, with today's advanced technology, the reloading costs may come down to a hundredth per tonne, compared to pure manual handling. The reduced transshipment costs have made it easier to combine different modes of transport with each other, thus achieving an even bigger market. At the same time, the number of transshipment points (terminals) has decreased; the fact is, that the new technology requires major initial investments that can be justified for only a limited number of places. Manual handling means only variable costs. In today's top-equipped terminals, the variable costs are small, but the fixed costs are high. In other words, they require large volumes to be cost-effective. Therefore, the terminals nowadays are fewer as well as bigger.

Manufacturing technology also developed in the direction of increased mechanization and automation, which favored large-scale operations.

New management philosophies such as *leanness* also contributed to a supply chain with a, more or less, continuous flow.

The above development has made it possible, to a greater extent, to carry out every manufacturing step in any place in the world where this can be done at the lowest cost. This has led to a geographically dispersed supply chain, often with a large number of links, here called the "global flow chain". In this flow chain, production is relatively evenly spread out throughout the chain, and the different links tend to be globally dispersed. Therefore, no single link is responsible for the main part of the value adding. Even the market for the products is often more or less global. Consequently, it is a global production for a global market with associated global transports and storage.

As for the products, they are basic products, necessary for everyday life as well as products that make life easier and enjoyable. They are largely mass-produced and standardized, but there are still some individually customized products available at a higher price. Although recycling occurs to some extent, the main direction of the chain is one-way, i.e. from raw material to refuse dump.

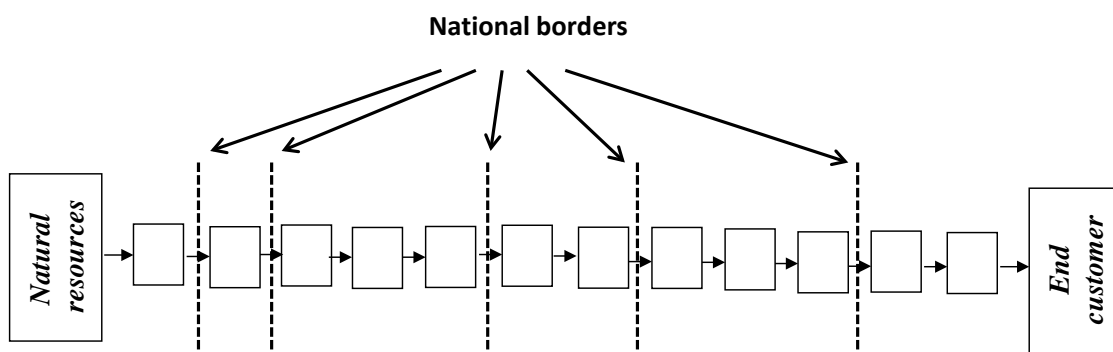


Figure 4.5: "The global flow chain".

4.3 The transformation onto the flow society

The above mentioned development means that Sweden in 150 years has been transformed from an agricultural community, based on local self-sufficiency, into an advanced industrial society. This industrial society is part of a global world market with highly integrated supply chains and a number of often globally dispersed links, in which a stream of input goods/services and finished products is constantly flowing - what we call the flow society. Figures 4.2 to 4.5 illustrate the transformation from *the farm* via *the factory* and *the regional supply chain*, into today's *global flow chain*.

4.4 New theories and methods

As a result of the increased need for transport and storage, the growing supply chain complexity and higher demands on its capacity, it became necessary to find new ways of looking at transport and storage. One such new approach was the logistics.

The basic idea behind logistics is to study the input flow, internal flow and output flow simultaneously and intermittently, as well as try to find the best overall solution to satisfy the customer. It may seem like a rather simple idea, but the application of it turned out to bring significant rationalization opportunities and the methods associated with this approach were also refined as time went by.

Logistics applications have since been developed and expanded to what we call *supply chain management* today or with a Swedish concept *flow economy*. From now on, the two concepts will be considered to represent the same meaning and therefore be used as synonyms.

Supply chain management involves a new way of thinking and acting, adapted to a new reality. The supply chain management theory says that the individual chain link should act upon what is best for the entire chain and that you should analyse the entire supply chain from end customer to natural resources from a total perspective. In practice, it can be difficult to grab all the links of the chain, nor is this always of interest, given the problem to be tackled. However, at least three full consecutive links must be included in the analysis.

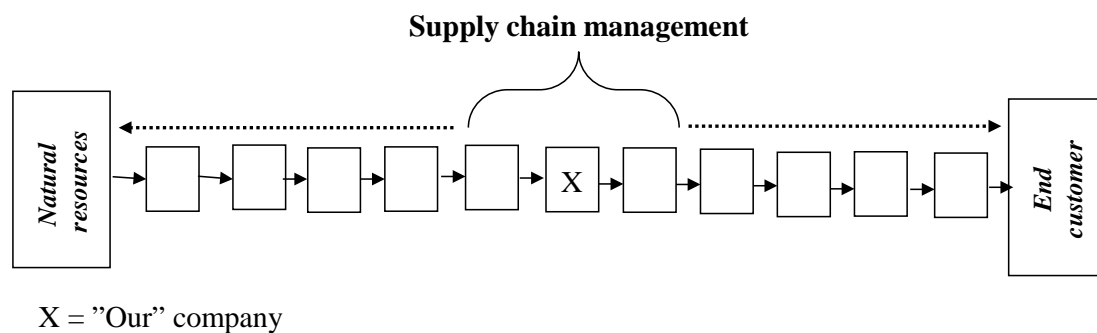


Figure 4.6: The supply chain and the possible extent of supply chain management.

More precisely, supply chain management means that you:

- act upon the needs and demand of the end customer
- try hard to increase the customer value of the end customer
- regard the whole chain as one single unit
- focus on the flow of the chain
- have the ambition to make everybody in the chain do what they do best
- assume that the chain's needs must be superior to the need of the individual link.

Especially the last phrase may seem a little strange. Why would the individual link choose to put the whole chain above the link itself? - Well, simply because the competitive conditions have changed. Competition no longer stands between different private companies, but between *different chains of companies*, i.e. different supply chains. Therefore, to give priority to your own chain is, at least in a slightly longer term, beneficial to your own link, even if it might cause some short-term disadvantages.

No company today can afford to be indifferent to its flows. They must devote time and attention to mapping the flows and their flow-related needs, as well as finding appropriate logistics solutions for them. Many companies go beyond that by applying the theories of supply chain management to their flows and by carrying out a more comprehensive analysis. For some companies, this analysis becomes extra important and comprehensive because they see an effective flow as an important means of competition that enables fast, safe and cost-effective deliveries. This is especially important when working with global purchasing and outlet markets.

In some cases, flow efficiency is the most important means of competition, since it enables lower end product prices, while maintaining a high delivery service and an increasing possibility for flexible, customized flow solutions.

Dell, for example, which sells computers and computer accessories on the internet, has no unique products in its product range (such as Apple), but through creative flow-based solutions they have managed to reduce their logistics costs so much that they can offer the customer an attractive low price. An example of creative solutions is *merge-in-transit*, i.e. that the different components of the ordered computer package (such as monitor, computer, keyboard and speaker) are sent directly by component suppliers to a 3PL company terminal, located close to the customer; there it is assembled by the 3PL company into a complete package (and not as usual at the sales company, i.e. in this case, Dell) before it is delivered to the customer.

When HM's creator Henning Persson was interviewed on his 80th birthday, he was asked why HM had been so successful. He replied that it was due to the turnover rate of the warehouse, meaning that HM was first within their line of business to realize the importance of the turnover rate to profitability. Thus, the focus was aimed at keeping track of current stock status, keeping the right things in the warehouse and also taking measures to reduce average sales times.

Ikea is famous for its flat packages and that the customer himself, in most cases, has to assemble the product at home. The Allen key is (along with the elk) the symbol of the company; this key has enabled the company to sell its products as flat packages and allow the customer to perform the final assembly. Flat packages mean reduced transport and storage costs, and also less handling damage. This makes it possible to have reduced prices on the products.

4.5 Some underlying trends

The opening of borders and the elimination of various border obstacles, as well as decreasing transport costs per tonne-km combined with increasing economies of scale in many businesses

has led to a rapidly *increasing competition*. Few companies today can settle down on a domestic market, of which they have more or less monopoly. Therefore, they have been forced to take different measures to make their own business more competitive and give it possibility to survive. These actions have created different trends, of which we are going to look at the most important ones:

A clear trend is *globalization*. From having previously purchased locally, the company now purchases from that place in the world where the price and quality of the current raw material, component or service is most favourable at the moment. Similarly, on the market side, we often see that sales of the same product, although in somewhat different variants, have gone from local to a wide variety of countries – sometimes worldwide.

There is a *concentration of production* into fewer and larger units with the aim of achieving reduced manufacturing costs per unit. At the same time, the geographical distance between producer and consumer has grown. Thus, the need for transport and storage has increased.

Outsourcing eliminates some of the manufacturing activities of the company itself, since it is considered that these activities are not part of the company's core business; instead the company purchases those services/components/products from outside at a lower cost. This creates more links in the chain.

By *concentrating the purchases* of an individual raw product, component or service to only one supplier (*single sourcing*) or perhaps two suppliers (*dual sourcing*), instead of as before having had several suppliers (*multi-sourcing*), you lower the purchase costs.

Through *leanness*, you aim at achieving the same production, e.g. in terms of the number of finished products, but with less resources. For instance, you try to decrease capital tied up, by reducing buffer stocks and introducing just-in-time deliveries.

With *shorter lead times*, you aim at delivering faster, but also at decreasing capital tied up.

Through *increased flexibility* you can faster adapt to the market's changing needs and to the increased demand for *customized* products.

But a trend cannot last forever. Sooner or later it hits the ceiling. For instance, there are individual products that are currently produced perhaps only in a handful of places in the world. Consequently, a further concentration of production can only be marginal. Increased labour costs in many of the former low-wage countries, growing oil prices and technology development are examples of factors that may affect current trend patterns. At present there are signs of a weakening of certain trends. An example of this is the increased existence of insourcing, i.e. the company once more chooses to produce what used to be outsourced. Another example is that companies that previously purchased from Southeast Asia now choose the European market instead. However, any clear signs of real trend failures cannot be seen at this time.

Together, these trends have created a flow chain in constant change, which has brought very positive results, but also created new risks, and not least disruption risks in the flows.

4.6 The impact of the trends on the company's vulnerability

4.6.1 The transfer point becomes central

Transfer point is the point in the chain where the product is transferred from an earlier link to a later one. At the point of transfer, there is an inspection and check-up between the delivery and the receipt link to ensure that the delivery is correct according to agreement. More specifically, it is the question of seven requirements to be met: that it is the right product; the correct number; and execution; with the right quality; at the right place; at the right time; and at the agreed price. Particularly important is to carry out a thorough quality check; partly because quality shortcomings may not appear until much later and then cause major problems, and partly because quality defects can be difficult to detect in a superficial control. If the delivery does not meet the requirements for the right product, the correct quantity and execution, at the right place, at the right time and at the agreed price, this will normally be detected immediately and can be rectified. The result may be an *immediate disruption* in the flow, but usually this error will be easily attended to without any disruption.

However, quality deficiencies are not that easy to detect at the time of transfer, but may appear after a long period of time and then result in delayed disruption and different forms of withdrawal of the defective products. A *delayed disruption* may in many cases have significantly greater negative economic consequences than an immediate disruption. Therefore, a thorough quality control at the transfer point is of main importance.

As the number of links in the chain has increased, so have the transfer points, and consequently their significance from a risk point of view. Another reason for their increased importance is that globalization of the chain has led to increased geographical spread of the chain's various links, which often results in differences between the links regarding, for instance, legislation and the way of organizing business and safety culture.

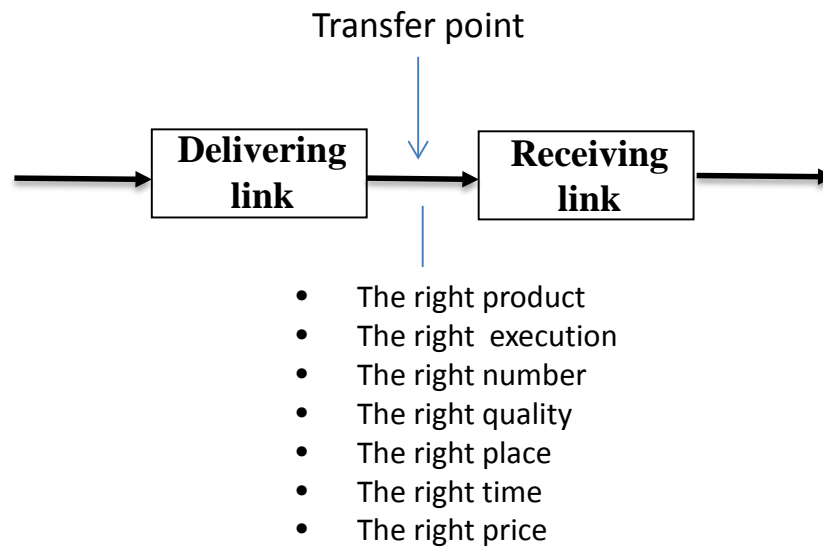


Figure 4.7: The transfer point with its seven requirements.

4.6.2 Increased risks

The trend towards flow chains with an ever greater number of links has increased the complexity of the chain and complicated the general view and control of the flow. In addition, the chains tend to be more and more globally dispersed, creating problems with different time zones, cultures, standards, legislation, etc. and of course increased transport times. The pursuit of resource efficiency has led to a significant reduction of different types of buffers such as security stocks, time buffers and overcapacity in production. If any disruption occurs, the alternatives for acting are few and narrow. The concentration of purchases of the individual input goods from only one supplier has created a strong dependence on the supplier's ability to deliver. If this ability should fail, and there are no alternative suppliers on the market to back you up, the situation rapidly becomes critical. Finally, the ever shorter life cycle of the products as well as the increased need to quickly launch the new product on the market is another problem; this creates a constantly changing flow chain that makes it difficult to find enough time to analyze the consequences of the design of the new changed flow chain for the company's risk picture.

The private company can therefore easily end up in a situation with increased likelihood of disruptions in the supply chain and potentially more serious negative consequences from the individual disturbance. Additionally, there is often a certain unawareness of how much the flow chains, and thus the risk picture, have really changed. Risk management has simply not fully adapted to the new situation.

4.6.3 Increased possibilities

There are also trends that create increased risk management possibilities. For example, today you can easily cross the borders of different countries within the EU. The possibilities of rapidly transporting things between different parts of the world have also increased, which in a critical shortage situation leads to greater opportunities for quick replenishment. But above all, the general development in the IT area has created new possibilities, such as the ability to automatically identify the goods by means of barcodes, and in real time to send information to other links of the chain of the whereabouts of a current shipment. Another example is the ability to via GPS find out where the individual lorry, railroad carriage or container is geographically. But above all, it is possible for different links of the chain to, through interconnected information systems, exchange information about sales, production planning, inventory status and the like. IT has also made it easier to find potential new suppliers and customers.

5 FLOW-RELATED DISRUPTION RISKS

5.1 What is risk?

Risk can be defined in different ways. In this book we will use as starting point a definition by Kaplan & Garrick (1981, p. 12–13) which defines risk as the answer to the following three questions:

- What can go wrong? (the scenario)
- How likely is it that it will happen? (likelihood)
- What are the focused negative consequences? (consequences)

The first question is answered by describing *the scenario*, i.e. the chain of events. The answer to the second question is *the likelihood for the scenario to take place* and which, e.g., can be expressed with a percentage rate. The answer to the third question is the negative consequences following the chain of events (the scenario). Thus, in principle a risk can be said to consist of three different elements - scenario, likelihood and consequences – in future called the three risk elements (a “triplet”). However, at first we have to decide what kind of consequences we wish to focus upon. From now on we will, if nothing else is indicated, act on consequences for the result. Depending on the type of business, the concept of *result* can mean different things. The business of a public orthopaedics clinic is not being evaluated by its profit size – on the other hand it is probably important that it stays within the budget parameters – but is rather evaluated by the number of well performed hip joint operations. From now on we will, however, (if nothing else is stated) assume that result is the same as profit or loss, i.e. the result corresponds to revenues minus costs. This means that we focus upon consequences that affect the revenues and/or costs. A scenario most often involves a number of different consequences. Some of these consequences may be positive, e.g. in the form of reduced costs. Only if the sum of all consequences is negative, we call it a risk. Should the sum be positive, it is not a risk but a possibility.

5.2 Disruptions/disturbance

Disruptions mean that we assume a stable or relatively stable flow, that the stable flow for some reason suddenly ends, in whole or in part, and that it takes some time before we return to a stable flow again. Or that we are in a new stable position, in the sense that the acute situation is over and we have created a new stability, for example by shutting down the production, expanding it or otherwise creating a situation we regard as stable.

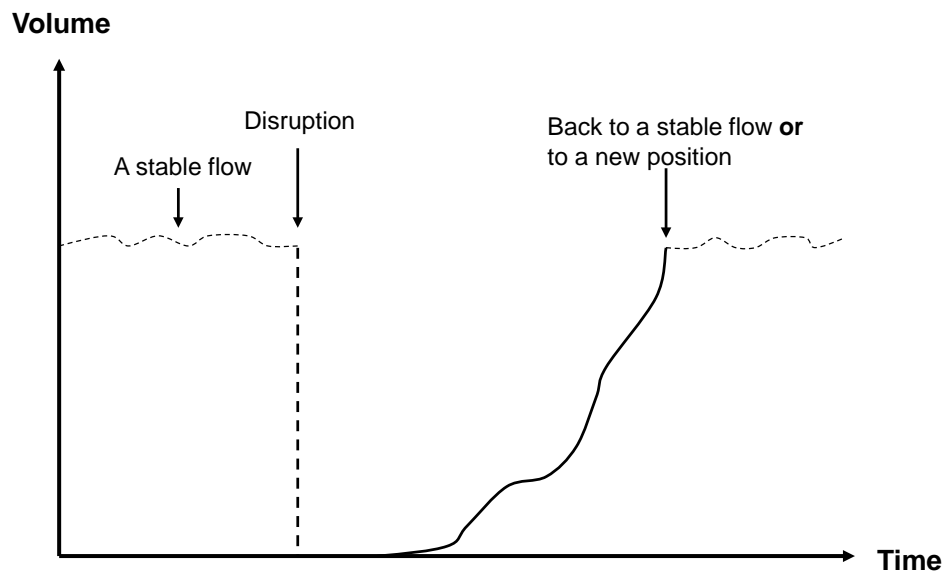


Figure 5.1: Illustration of the concept "disruption".

When we study a flow disruption in detail, we can often see that it is reasonable to watch not only the events that occur during the disruption but also those events that led to the actual disruption as well as those coming afterwards, when we are back in a stable flow again. Such a chain of events is usually called a "risk scenario". Many of these events have a result impact.

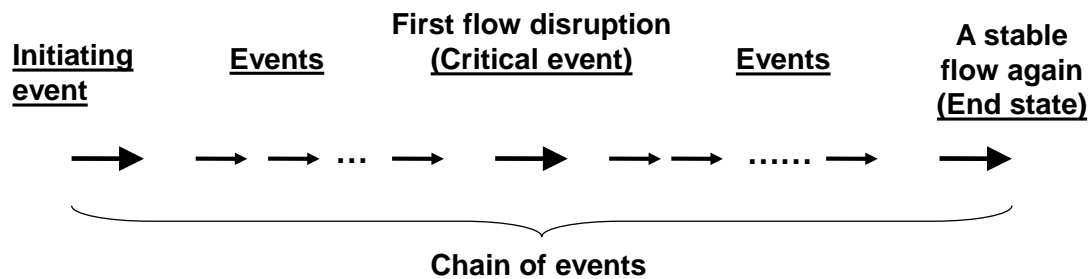


Figure 5.2: Description of a risk scenario course of events (Paulsson 2007, p. 208).

5.3 An illustrative example

Suppose the company DCBA wishes to calculate the total negative result impact of a certain risk option to which the company is exposed. For the current risk option, the triggering event is a machine breakdown at supplier B, a first-line supplier that delivers the, for DCBA, critical component X. Assume further that the machine breakdown leads to four-week break in deliveries from B and that the likelihood that this will happen is 1 out of 50, and the company has a buffer stock of one week for component X, but no inventory of finished goods. Assume further the following:

- 1 The company succeeds to purchase a week's delivery of component X on the spot market from another supplier, however at a higher price. No more components can be bought on the spot market. Nor does the company succeed in finding any suitable replacement component.
- 2 Since there are no deliveries of component X from the regular supplier in four weeks, the company does not need to pay the supplier during this period.
- 3 Of the four week-break, one week can be absorbed using the buffer stock and another week by purchasing from another supplier. The remaining two disruption weeks the company is forced to transfer on to the customers (market) as non-deliveries, and the company will lose sales revenue for these two weeks.
- 4 The company has a disruption insurance valid for production breaks lasting more than one week, and a certain amount of compensation is now disbursed from the insurance company.
- 5 When component X shipments get started from B, the company can once again start producing and delivering its product. In the short term the company's customers will, due to the two week-delivery break, increase their purchases from the company to build up their own stocks, and sales revenues will consequently go up. Also the company's cost for purchasing component X will increase (because they buy more than usual), but not that much. So, in the short run, the company's profit will increase compared to normal circumstances.
- 6 When the customers in due course have purchased enough for their store rooms, it is time for the company to rebuild its own buffer stock.
- 7 In the long run, however, the company's sales and profits will decrease because the market no longer considers the company to be an equally reliable supplier as before the disruption.
- 8 There is a certain annual cost to keep a buffer stock of component X.
- 9 There is an annual insurance premium to be paid for the disruption insurance.

Items 8 and 9 above occur regardless of whether a disruption takes place or not. They signify a *known* result impact. Items 1 to 7 above, however, only occur if a disruption takes place and the likelihood of this is 1:50. These items therefore represent an *expected* result impact.

Table 5.1: Economic consequences of a certain risk scenario at the company DCBA.

Event	Risk management method	Result impact
1	<i>Buy components at a higher price</i>	-130
2	<i>No supplier settlement for four weeks</i>	300
3	<i>Lost sales for two weeks</i>	-320
4	<i>Compensation from the insurance company</i>	55
5	<i>Increased short-term profit</i>	270
6	<i>Rebuilding the buffer stock</i>	-75
7	<i>Lost long-term profit</i>	-500
	Result impact	-400
	<i>Likelihood</i>	1/50
	Total expected result impact	-8
8	<i>Annual cost for buffer stock</i>	-5
9	<i>Annual insurance premium</i>	-2
	Total known result impact	-7
	Total negative result impact for the risk scenario	-15

5.4 Take an insurance policy and sleep peacefully

"Take an insurance policy and sleep peacefully" is nowadays not a good call; simply because the insurance services existing on the market today tend to cover less and less of the total negative result impact that a disruption may cause. If the factory is on fire, we may get money from the insurance company to build a new factory, but hardly any compensation for lost future market shares. One of the researchers that has taken an interest in the economic impact of a disruption is Reason (1993). He states:

For each pound in costs that can be compensated through insurance, an additional 5-50 pounds will be added to the final cost due to a long line of other financial losses.

James Reason 1993, "Managing the risks of organisational accidents", p. 10.

Reason mentions lost production and lost sales as examples of other financial losses

5.5 Domino effects

Disturbances and smaller disruptions are part of the everyday life of companies and organizations, and in most cases the disturbance or disruption can be managed within the link where it occurred. In some cases, however, the disturbance/disruption will propagate to the next link in the chain and perhaps even to several subsequent links. This is what we call domino effects.

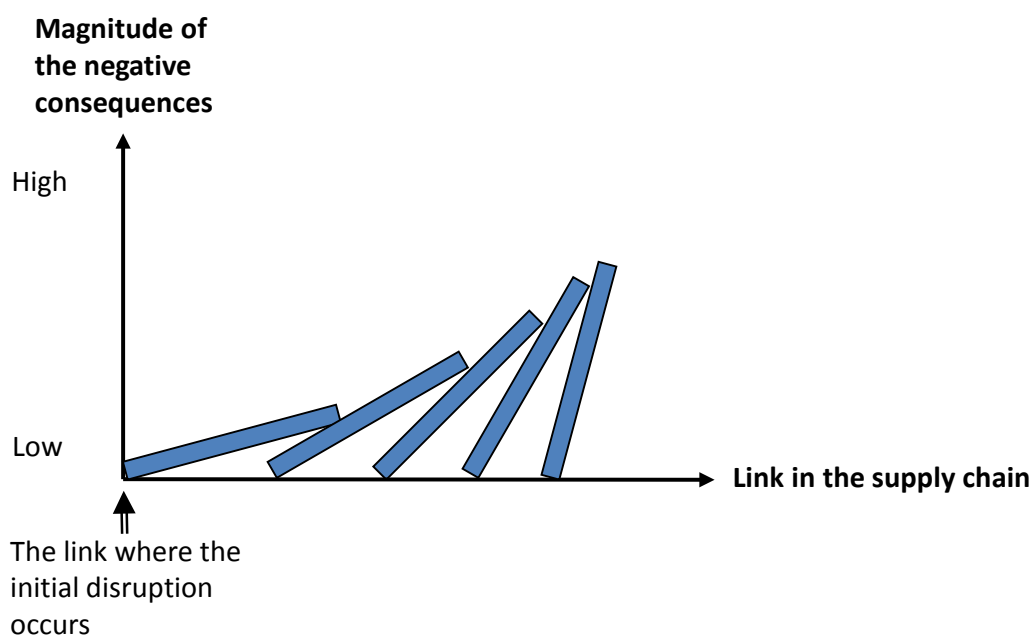


Figure 5.3: Illustration of the concept domino effects.

These effects can be of two different types: escalating (increasing) and de-escalating (declining). It is true that declining domino effects mean that the disturbance propagates to several links, but that the negative consequences tend to decrease with each link. However, with increasing domino effects, the negative consequences tend to be greater with each link. In both cases, there is a negative result impact, but of course the latter alternative is the most important situation to pay attention to.

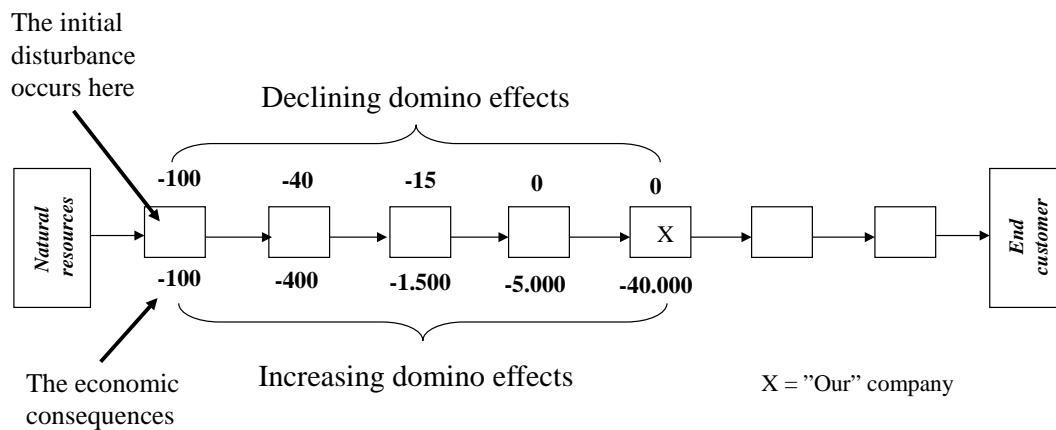


Figure 5.4: Illustration of declining and increasing domino effects.

5.6 Sometimes misfortune strikes

On July 22, 2000, the following could be read in the economy section of *Sydsvenska Dagbladet*:

“But after a fire in a Philips plant in New Mexico, USA, the shortage of components, which previously has reduced the company’s profit, has become worse. Kurt Hellström states that the fire is the only explanation of the presented loss figures”.¹

Sydsvenska Dagbladet July 22, 2000, p. A10.

During a heavy storm the lightning struck down in the plant and a fire occurred in a manufacturing room. The fire caused the fire alarm to go off, the sprinkler system was triggered, the staff started putting out the fire and the local fire department was called in. The fire was quickly extinguished by the staff so when the firefighters arrived at the plant, their only task was to check on-site that the fire was really out. Thus, the fire itself was limited. The problem was that it started in a *clean room*, where microchips to different customers were manufactured with extreme demands on a particle-free environment. The room was now polluted by a lot of particles that ruined the production equipment, why production was not possible anymore. In addition, the extinguishing work itself had also caused other clean rooms in the plant to be contaminated.²

Nokia was also affected by the Albuquerque accident but quickly realized the consequences of the fire on the component flow and took countermeasures. For instance, the managing director

¹ 1,8 billion Swedish crowns (SEK) in loss the first six months in 2000 for Ericsson’s mobile telephone unit.

² Sheffi, Y. (2005). *The Resilient Enterprise – Overcoming Vulnerability for Competitive Advantage*. p. 3 – 4.

(MD) Jorma Ollila, who was travelling from the United States home to Finland, redirected his plane and went straight to Eindhoven where Philips has its headquarters and managed to get Philips to find any available capacity in some of their other plants, which alleviated the effects. When Ericsson, which was significantly worse off than Nokia, a little later realized that the fire could lead to delivery problems, all available capacity was already booked. But Nokia also had several suppliers of the same component (*multi-sourcing*) whereas Ericsson had relied on only one supplier (*single sourcing*). Besides, Nokia was using a modular engineering design which made it easier to find new suppliers. Within six months after the fire, Nokia's mobile phone market share had increased from 27 to 30 per cent, while Ericsson's sales decreased from 12 to 9 per cent.³

³ *Ibid.* p. 5 – 10.

6 THEORY AREAS THAT ADDRESS FLOW-RELATED RISKS

6.1 Supply chain risk management

Supply chain risk management is a comparatively new area for research and implementation. It could be described as the intersection of two well-established areas: risk management and supply chain management.

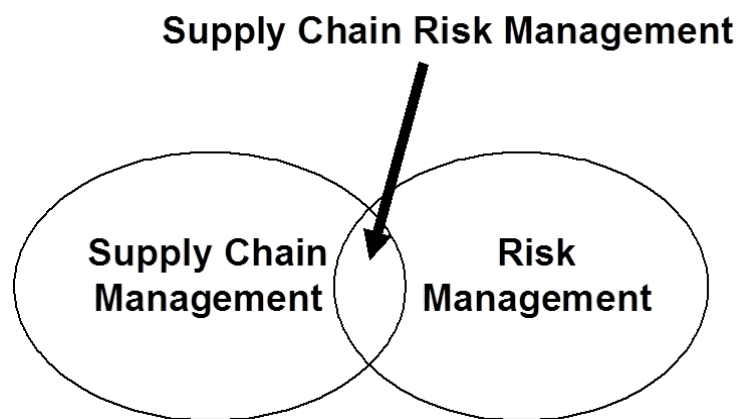


Figure 6.1: Supply chain risk management described as the intersection between risk management and supply chain management. (Paulsson 2004, Supply Chain Risk Management. I: Brindley, 2004, p. 80.)

There are several different definitions of supply chain risk management. One of them reads as follows:

“Supply chain risk management is to use risk management process tools in cooperation with partners in a supply chain to deal with risks and uncertainties caused by or affecting logistics-related activities in the supply chain”.

Norrman & Lindroth, 2002, “Supply Chain Risk Management Purchasers’ vs. Planners’ View on Sharing Capacity Investment Risks in the Telecom Industry”, s. 7.

6.2 Some other theory areas

Some other theory areas dealing with flow-related risks are *business continuity planning* (BCP), *business continuity management* (BCM) och *enterprise-wide risk management* (EWRM). Within BCP, i.e. continuity planning, the possibilities are considered to return to normal activity again as soon as possible if, after all, there is a disruption or a disturbance. BCM focuses on the few and minor disturbances that may occur in the business. The EWRM, finally, is a significantly more comprehensive area and handles all the company's critical risks, wherever they exist within the enterprise.

7 EFFICIENT RISK MANAGEMENT IS INCREASINGLY IMPORTANT

To completely avoid disruptions and disturbances can be difficult, and may not even be desirable given the high risk management costs that this probably would require. However, it is important not to be affected unnecessarily hard. In competitive activities it is also important not to suffer worse than the competitors; of course you should rather suffer less. Efficient risk management can represent an important competitive advantage here, as illustrated by Ericsson - Nokia and the Albuquerque accident.

The company's supply chain and its environment are constantly changing, which affects the company's risk profile. If you, in spite of this, keep on handling risk management as if nothing has happened, the threats will increase. But changes in supply chains and their outside world have also created new opportunities, as for example in the IT area, to manage the risks of disruption. It is important to take advantage of these opportunities through the introduction of new flow-based organizational risk management solutions, supported by a risk culture that emphasizes that risk management is everyone's responsibility.

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Sydsvenska Dagbladet, den 22 juli 2000.

HAZARD project has 15 full Partners and a total budget of 4.3 million euros. It is executed from spring 2016 till spring 2019, and is part-funded by EU's Baltic Sea Region Interreg programme.

HAZARD aims at mitigating the effects of major accidents and emergencies in major multimodal seaports in the Baltic Sea Region, all handling large volumes of cargo and/or passengers.

Port facilities are often located close to residential areas, thus potentially exposing a large number of people to the consequences of accidents. The HAZARD project deals with these concerns by bringing together Rescue Services, other authorities, logistics operators and established knowledge partners.

HAZARD enables better preparedness, coordination and communication, more efficient actions to reduce damages and loss of life in emergencies, and handling of post-emergency situations by making a number of improvements.

These include harmonization and implementation of safety and security standards and regulations, communication between key actors, the use of risk analysis methods and adoption of new technologies.

See more at: <http://blogit.utu.fi/hazard/>

