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Abstract
V&S Sundsvall (a part of V&S Vin & Sprit AB) is a Swedish company producing different alcoholic beverages, mainly for the Swedish market. The company has lately paid increasing attention to supply chain disruption risk issues.

In another study, one of the authors (Paulsson 2007) developed a model, called the DRISC (Disruption Risks In Supply Chains) model, for the structuring, evaluation and handling of risks related to disruptions in the product flow in the supply chain. The DRISC model covers, from the viewpoint of an individual (focal) company in the supply chain, all product flow-related disruption risks in the total supply chain from natural resources to the delivered final product, and makes it possible to classify the risks, measured as negative result impact, into 15 different risk exposure boxes and thereby to get a "picture" of the disruption risks in the company. In the risk evaluation part of the DRISC model, new alternatives for handling those risks are generated with the help of a list of 22 identified generic risk handling methods.

On V&S Sundsvall, the partial risk analysis model was applied first and resulted in a certain risk picture. The risk analysis revealed a couple of risk boxes with a high risk level and also identified a number of individual hazards. Then, based on this risk picture, the partial risk evaluation model was applied. The risk evaluation resulted in a list of some 50 different potential risk-handling alternatives for improved handling of the disruption risks in the supply chain.

The application of the theoretical DRISC model on the empirical case V&S Sundsvall indicated that the model can be a useful "tool" when doing supply chain disruption analyses in the liquid food production industry, and also produced some ideas for refinements of the model.

Sammanfattning

Potentiella riskhanteringsalternativ för störningar i försörjningskedjan
vid produktion av flytande livsmedel
– fallet V&S Vin & Sprit AB, Sundsvallsfabriken

V&S Sundsvall (en del av V&S Vin & Sprit AB) är ett svenskt företag som producerar olika alkoholhaltiga drycker huvudsakligen för den svenska marknaden. Företaget har på senare tid ägnat ökat intresse åt frågor gällande avbrottsrisker i försörjningskedjor.

En av författarna har tidigare i en annan studie (Paulsson 2007) utvecklat en modell, kallad DRISC (Disruption Risks In Supply Chains) modellen för strukturering, värdering och hantering av risker relaterade till störningar och avbrott i försörjningskedjan. DRISC modellen täcker, sett från synvinkeln av ett individuellt (fokalt) företag i försörjningskedjan, alla produktflödesrelaterade störningar i hela kedjan allt från naturresurser till levererad slutprodukt och gör det möjligt att klassificera dessa risker, mätt som negativ resultatpåverkan, i 15 olika riskexponeringsrutor och härigenom få en "bild" av företagets störningsrisker. I utvärderingsdelen av DRISC modellen genereras sedan med hjälp av en lista över 22 olika generiska riskhanteringsmetoder nya alternativ för att hantera dessa risker

På V&S Sundsvall tillämpades först delmodellen för riskanalys resulterande i en viss riskbild. Riskanalysen avslöjade ett par riskrutor med en hög risknivå och identifierade även ett par enskilda hot. Sedan tillämpades, baserat på denna riskbild, delmodellen för riskutvärdering. Riskutvärderingen resulterade i en lista med cirka 50 olika potentiella riskhanteringsalternativ för bättre hantering av störningsriskerna i försörjningskedjan.

Tillämpningen av den teoretiska DRISC modellen på det empiriska fallet V&S Sundsvall indikerade att modellen kan vara en användbart hjälpmedel när man gör

analyser av störningsrisker i försörjningskedjan inom industri med inriktning mot produktion av flytande livsmedel och gav även några idéer till mindre förbättringar av modellen.

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Foreword

This report has been produced within the SIK (The Swedish Institute for Food and Biotechnology) project ”Modellering av spårbarhet och riskanalys för säker och hållbar livsmedelsproduktion” (Modelling of traceability and risk analysis for safe and sustainable food production).

Many thanks to all the participants in the SIK project for interesting and fruitful discussions. Our appreciation also goes to VINNOVA (The Swedish Governmental Agency for Innovation Systems), which has provided financial support via SIK .

We also owe great gratitude to people in V&S Vin & Sprit AB, especially Minna Bäckman and Åsa Orsvärn, for their willingness to share knowledge, insights and information.

The work on this report has been conducted parallel with the writing of a thesis by one of the authors – Ulf Paulsson. The thesis was defended in October 2007 – a couple of months before the publication of this final report.

Lund, June 2008

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1. Introduction

1.1. Background

1.1.1 Empirical background

A number of *severe company events* caused by supply chain disruptions have occurred during recent years. One example is Ericsson and the Albuquerque event back in 2000[1] [2]. A minor fire in a production cell, a so-called clean room, at a sub-supplier's plant in Albuquerque, New Mexico (USA), caused by a lightning fire affecting the delivery of electricity for about ten minutes, made the production room unclean and destroyed the production equipment. From a plant perspective the impact was low, but for Ericsson it was huge because the needed component – a radio frequency chip – was single sourced. Even after 6 months the production of chips was only 50 % of what it should have been. Ericsson lost many months of mobile phone production. The accident also had an impact on Ericsson's decision to withdraw from the mobile phone terminal business. Another example is Nilsson (false name), a Swedish steel producing company selling special steel qualities[3]. Production is complex, includes handling of dangerous material, and has long lead times. JIT-principles were not used except for a few input areas like hydrogen gas, where there was a constant inbound flow. Hydrogen gas, which was single sourced, was bought from a supplier who had built a hydrogen plant just a few hundred meters away from the factory, delivering the gas in a special pipeline. A mistake by some hired craftsmen doing maintenance work at the hydrogen supplier's plant caused an explosion in the hydrogen factory and destroyed it completely. Production at Nilsson had to stop totally for a month, and it took several months before it was back to normal again. Their most important customer chose to end the business relation even though Nilsson, with the help of their inventory of finished goods, managed to maintain deliveries. Other deliveries were severely delayed. Sale and market shares were lost.

[1] Sheffi, Yossi (2005) *The Resilient Enterprise*. The MIT press.
[2] Norrman, A. & Jansson, U. (2004) "Ericsson's proactive supply chain risk management approach after the Albuquerque accident". *International journal of physical distribution & logistics management* Volume 34, number 5.
[3] Artebrant, Jönsson & Nordhemmer (2004) *Risks and risk management in the supply chain flow – a case study based on some of Marsh's clients*. Master's thesis. Lund Institute of Technology.

In this study the empirical focus is on V&S Sundsvall. V&S are also looking for ideas about other possible improvements in the management of the supply chain flow related disruption risks[4].

1.1.2 Theoretical background

Risk is defined by The Royal Society *"as the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge"*[5]. To be able to come to grip with risks, risk management is needed. The same source defines risk management as *"the process whereby decisions are made to accept a known or assessed risk and/or the implementation of actions to reduce the consequences or probability of occurrence"*[6]. Formulated in another way: *"Risk management means taking deliberate action to shift the odds in your favour"*[7].

Company risks of different kinds have received increasing attention during the last decade both in media[8] and as a research topic. In some countries, new legislation has been introduced making it compulsory to include risk assessment information in the annual report. This study focuses on the *supply chain flow risks* where *risk* is defined as *an event with negative economic consequences*.

The chain of transport and storage activities from first supplier to end customer has changed character over the years, and gradually developed from a step-wise chain via a logistical chain into a supply chain[9]. *Competition* is no longer between different individual companies but *between different supply chains* offering similar products to an end customer[10]. Consequently, the focus ought to be on the supply chain and not on the individual company. The problem is that the supply chain does not exist from a legal point of view and hence the supply chain cannot take actions – only the individual companies in the chain can act. With competition changing from

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4 Ohlsson, D. & Svensson, S. (2005) *DOSS – Värderingsmodell för riskerna vid tillverkning av flytande livsmedel*. Master's Thesis in Technology Management. Lund University.
5 *Risk: Analysis, Perception and Management* (1992). Report of a Royal Society Study Group. The Royal Society. London, p.2.
6 *Risk: Analysis, Perception and Management* (1992). Report of a Royal Society Study Group. The Royal Society. London, p.5.
7 Borge, Dan (2001) *The Book of Risk.* John Wiley & Sons Inc. New York, p.4.
8 Simons, Robert (1999) "How risky is your company?". *Harvard Business Review*, May-June 1999.
9 Cooper M., Lambert, D. & Pagh, J (1997) "Supply Chain Management: More Than a New Name for Logistics". *The International Journal of Logistics Management.* Volume 8, Number 1.
10 Christopher, Martin (1998) *Logistics and Supply Chain Management.* 2nd ed. Financial Times/Pitman Publishing, p16.

companies to supply chains, it has become very important for the individual company to be a "member" of a competitive supply chain that gives the company a fair share of its surplus. That will not happen by itself. It has therefore become essential for the individual company to "create its own" supply chain alternative, i.e. to find out what consequences different design alternatives have for the competitiveness of the supply chain and the company, and to actively promote supply chain design alternatives with high competitiveness.

So far, short-term operational efficiency issues seem to have dominated this design work. But every supply chain design alternative also includes risks of different kinds, and the supply chain tends to be increasingly vulnerable. Many firms that earlier realised that the biggest opportunities to increase their competitiveness did not lie in improving their internal efficiency but in supply chain design and integration are now realizing that the biggest risks to the company are not within the company itself but in its dependency on the supply chain. Disruptions in one link of the chain could easily spread to other links in the chain (domino effects). In some situations the negative economic consequences also tend to grow worse for each link, and we can here talk about *escalating domino effects*. In combination with often limited liability for the individual link, this means that companies further down the supply chain could actually be much more severely hit than the link where the initial disruption took place.

A number of *trends* during the last decade have affected the supply chain risk situation. One is that the supply chain should be lean, another that it should be agile as well[11] [12]. A third trend is outsourcing, resulting in more links in the chain. Single sourcing is still another trend. And of course globalisation. All these trends (and others as well) tend *to make the supply chain more vulnerable*. Christopher & Lee[13], for instance, have pointed out that *"Managing supply chains in today's competitive world is increasingly challenging"*. And the trends change customer demands as well, as e.g. Schwartz[14] has underlined *"/…/ in many cases, customers are demanding to see proof that a business is ready for trouble before they will award it a major contract or place a company within its supply chain of manufacturing"*.

Consequently, there is *a need for models* with the help of which risks related to disturbances or disruptions in the physical flow in a supply chain can be identified,

[11] Christopher, M. & Towill, D. (2000) "Supply chain migration from lean and functional to agile and customised". *Supply chain management: An International Journal*, Vol. 5, No 4, pp.206-213, 2000.
[12] Mason-Jones, R., Naylor, B. And Towill, D. (2000) "Engineering the eagile supply chain". *International Journal of Agile Management Systems*. 2/1.
[13] Christopher, M. & Lee, H. L. (2004) "Mitigating supply chain risk through improved confidence". Article in *International journal of physical distribution & logistics management.* Volume 34, number 5, 2004.
[14] Schwartz, John (2003) "Disaster Plans Get New Scrutiny After Blackout". *New York Times*, August 19, 2003.

structured, described and analysed. Such models are of interest to academia and to company management, employees, shareholders, local communities, and other stakeholders. One of the authors has earlier in another study developed a supply chain flow aggregated risk model – called the DRISC model – for the structuring, evaluation and handling of risks related to disruptions in the physical flow in the entire supply chain.

One company that has paid increasing attention to those issues is Vin och Sprit (V&S) AB. An incident in January 2006 at their Sundsvall site involving contaminated light mulled wine (lättglögg) that led to the withdrawal of all existing bottles of Blossa lättglögg on the market further increased this interest. (Lättglögg is light mulled wine with a low percentage, max 2,2 %, of alcohol. It is usually served warm with raisins and almonds.)

In another study, one of the authors (Paulsson 2007) developed a model, called the DRISC (Disruption Risks In Supply Chains) model, for the structuring, evaluation and handling of risks related to disruptions in the product flow in the supply chain. The DRISC model covers, from the viewpoint of an individual (focal) company in the supply chain, all product flow-related disruption risks in the total supply chain from natural resources to the delivered final product, and makes it possible to classify the risks, measured as negative result impact, into 15 different risk exposure boxes and thereby to get a "picture" of the disruption risks in the company. In the risk evaluation part of the DRISC model are then new alternatives for handling those risks generated. The risk analysis phase and the risk evaluation phase in this model will here be applied on V&S Sundsvall AB.

1.2. Objectives

The *first objective* of the study is to apply the risk analysis phase of the DRISC model on Vin & Sprit AB, the Sundsvall site, to map the disruption risks linked to the production of liquid, alcoholic, food products with a special focus on Blossa lättglögg (light mulled wine; see above).

The *second objective* of the study is to apply the risk evaluation phase of the DRISC model on Vin & Sprit Sundsvall to acquire ideas for possible improvements in the handling of those risks.

The *third objective* of the study is to gain experiences of the empirical usefulness of the DRISC model when doing supply chain disruption analyses in the liquid food production industry, and to obtain indications of suitable adjustments in the DRISC model.

1.3. Report overview

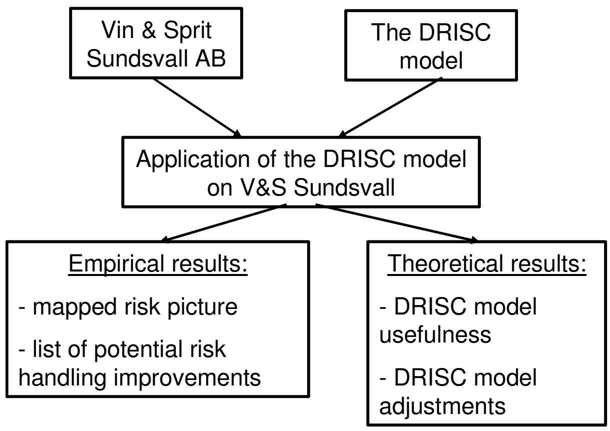

Figure 1.1: Report overview

2. Presenting the DRISC model

This chapter is based on a doctoral thesis[15] which in its turn has been inspired by two different papers[16 17], and a book chapter[18].

2.1. Some theoretical starting points

A result-oriented perspective
A result is that which someone or something, such as an organisation or a company, wants to reach. The result might be specified in many different ways/dimensions as e.g.:

- number of successful operations performed;
- number of students examined;
- shareholder value; and
- business profit.

It is up to the user of the DRISC model to specify what kind of result dimension he or she wants to choose and thus what in the specific application is meant by *result impact*.

Product flow focus
There are a number of different flows in the supply chain, like product flow, information flow and financial flow. Our focus will be on the product flow, where *product* is defined as *something one gets paid to deliver*. It could be a physical product, a service or a mixture of both.

Focal unit perspective
The supply chain is looked upon from the point of view *of an individual unit in the chain*. That particular unit is called the *focal unit* and might be a single company, a group of companies, an organisation, a group of organisations, a working site, a legal unit or some other specified unit in the supply chain that the users of the DRISC model choose to select as their focal unit. *Focal unit* is thus defined as *the individual unit in the*

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[15] Paulsson, Ulf (2007) "On managing disruption risks in the supply chain – the DRISC model". *Doctoral thesis, chapter 8*.
[16] Paulsson, Ulf (2005a) "Developing a Supply Chain Flow Risk Model". Final paper to the *NOFOMA 2005-conference*.
[17] Paulsson, Ulf (2005b) "Valuation of Supply Chain Flow Risks by Indexing". Work-in-progress paper to the *NOFOMA 2005-conference*.
[18] Paulsson, Ulf (2004) *Supply Chain Risk Management*. Chapter 6 in Brindley: Supply Chain Risk: A Reader. Ashgate.

supply chain from the perspective of which the supply chain flow risk issues are seen, interpreted and acted upon.

Focal product perspective
In many cases where the focal unit is producing more than one product, the focal unit is a "member" of several different supply chains where each supply chain is based on a certain product or product group. One has to be chosen. Focal product is thus defined as the individual product or product group that the focal unit chooses to study. So when we talk about "a focal unit perspective" we actually mean from the perspective of a certain focal unit *and* a certain focal product.

Pre-period time perspective
The perspective is *a pre-period time perspective* where period is the chosen time period for the project in question e.g. 1/1 – 31/12 the coming year. This means that we try to act before something happens and thereby eliminate the event or affect the likelihood and/or the negative consequences of the event. When we imagine the negative consequences, we suppose that if an event happens, normal suitable risk handling actions will be taken to mitigate the negative consequences.

Supply chain choice
Since one and the same product can be using different supply chain alternatives, e.g. the product can be distributed through several parallel distribution channels, it may also be necessary to specify a supply chain alternative.

Marginal changes in the supply chain
The DRISC model will deal with *marginal changes* in a planned or an already existing supply chain with its current policy for handling disruption risks. The DRISC model assists in the search for alternatives to handle the disruption risks in this supply chain in a more effective and efficient way.

Risk definition
Risk is according to Kaplan (1997) defined by answering the three questions; What can happen?, How likely is it that it will happen?, and If it does happen, what are the (negative) consequences?[19] An answer to those three questions is by Kaplan called a triplet.

Focus on disruption risk exposure
Since the perspective is a pre-period time perspective, the focus is not on actual disruptions but on *disruption risk exposure*. Given the production of a certain focal product in a certain focal unit in a certain supply chain setting, a disruption risk exposure might exist. A risk exposure exists when there is a possibility that an event with negative result impact is going to happen. In this study the top event is a

[19] Kaplan, S. (1997) "The Words of Risk Analysis". *Risk Analysis*.

disruption in the supply chain. This means that the focus is on the *negative result impact (NRI) for the focal unit with its focal product of supply chain disruption risk exposure*.

Risk handling

The focal unit reacts to the risk exposure through risk handling. The potential events cause pre-event and post-event handling. The *pre-event handling* could mean that actions are taken, like buying new insurance or building up a buffer stock, to eliminate or mitigate the risk. One could also choose not to act because that is seen as more favourable than acting (we simply accept the risk as it is). But not acting could also follow from a situation where the risk is not affectable. In both cases the disruption is sent on to post-event handling.

Post-event handling could mean taking actions like working overtime or temporarily buying from another supplier. There are two basic ways for the focal unit to handle a disruption that has taken place: to handle the disruption within the focal unit or to let the disruption out of the focal unit by passing it on. Disruptions are passed on for two different reasons. One is that the negative result impact of the disruption will be lower if passed on than if handled internally. The other is that it has to be passed on because it cannot be affected internally. The latter will also be seen as risk handling, since in most situations you have the possibility to eliminate the risk totally by stopping producing the focal product.

Pre-event handling in the form of actions will be called *preventive measures*. Post-event handling in the form of actions will be called *internally handled*, and in the form of not acting passed on. There exist in other words three basic ways to handle risk exposure: preventive measures, internally handled and passed on.

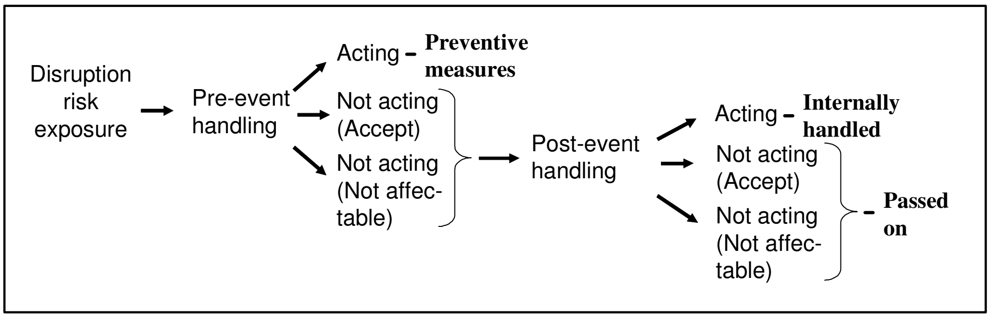


Figure 2.1: Disruption risk exposure and risk handling

In the individual situation one, two or all three ways of risk handling can be applied (risk handling mix). By making changes in the risk handling mix, the total negative result impact can be affected.

Disruption risk exposure
If the focal unit had not been subject to any disruption risk exposure in the supply chain flow, its estimated future result would have been of a certain size. But now since the company is exposed to certain disruption risks, the estimated future result is less favourable. The difference can be regarded as *the total negative result impact from the disruption risk exposure*. The focal unit wants to keep this difference as small as possible.

Disruption risk definition
The normal product flow creates a normal result. A negative impact is then a decrease in this normal result. The normal product flow in the supply chain includes frequent, small disruptions up to a certain level, because it is normal to have such minor disruptions. I can now, for the DRISC model, define *negative consequence as a consequence of a disruption in the supply chain product flow that in comparison with the normal result created by the normal product flow has a negative result impact.*

Risk scenario description
A risk scenario can basically be described as a chain of events starting with initial event and ending with end state. Between those one or more mid states could exist. In complex scenario situations there will probably be a number of mid states. Often we have a special interest in one of those mid states and that mid state will here be called *"critical mid state"*.

As soon as we apply the risk scenario model on a certain context a number of specifications are necessary. We might need to specify initial event, critical mid state and end state. We might for instance only be interested in fires in private houses (Critical mid state) caused by short circuit in old electrical systems (Initial event) and our interest ends when the fire has been extinguished (End state).

In the DRISC model critical event is specified as *"a supply chain product flow disruption which constitutes the first disruption in a risk scenario"*. What characterises the "end state" also has to be defined, and the chosen definition is here; when we are *"back to a stable flow again"*. Consequently, there is a stable flow, something happens (initiating event) that starts a chain of events, including a critical event, that ends when we are back to a stable flow again.

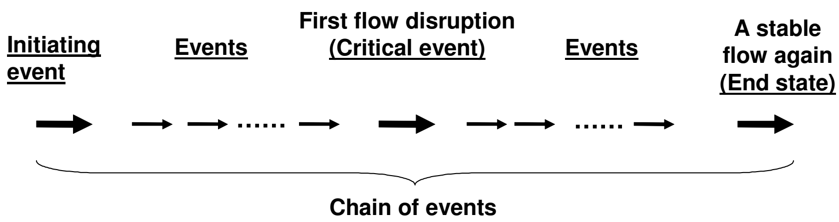
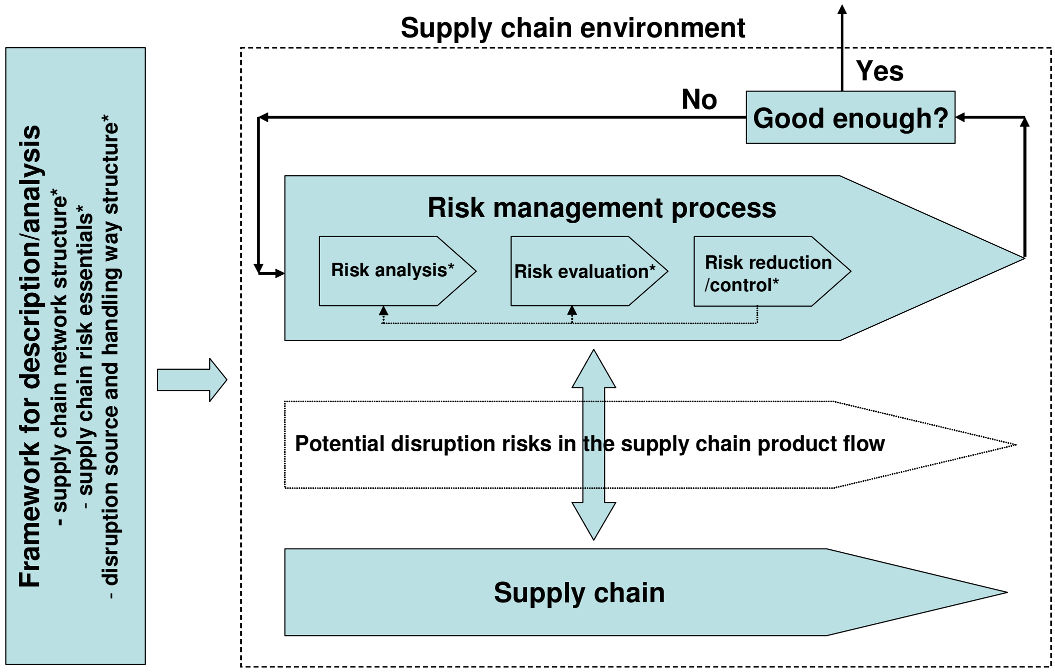


Figure 2.2: Illustration of a scenario with a critical event in the DRISC model setting

2.2. The DRISC model on the top level

The object of our interest is the *potential disruptions risks in the supply chain product flow*. These are the result of the supply chain itself and of how its risks are managed. Those two – *the supply chain* and *the risk management process* – are in constant interaction. The supply chain with its product flow creates risks. Some of those risks are handled in the risk management process by finding and implementing certain risk handling actions. Those actions change the supply chain in one way or another. A changed supply chain creates a new risk situation to which risk management might then react with new risk handling actions, and so on.

These three *basic elements* – the supply chain, the risk management process and the potential disruptions risks in the supply chain product flow – and their interaction can be identified, described and analysed in a number of ways. It is, however, advisable to have certain fixed structures that govern how these three basic elements and their interaction are identified, described and analysed. Those fixed structures will be called the *framework for description and analysis*, which is the fourth basic element of the DRISC model. Changes in the supply chain (and, as a consequence, also changes in risks) can be internally generated within the supply chain but can also come from outside the supply chain – from its *environment*. Therefore the environment of the supply chain is included in the model as a fifth basic element. After we have been through all the different steps in the risk management process we need to ask ourselves if the risk situation now is "good enough" or not. If the answer is "no", a new risk management process "round" is initiated.



* = Including detailed model on at least one lower level

Figure 2.3: The DRISC model – top level (Level 1)

We will now take a closer look at some of the partial models

2.3. Framework for description and analysis

The framework for description and analysis consists of: *supply chain network structure, supply chain risk essentials, and disruption source* and *handling way structure.*

Framework for description and analysis

- **Supply chain network structure**
- **Supply chain risk essentials**
- **Disruption source and handling way structure**

Figure 2.4: Framework for description and analysis model – Level 2

2.3.1 Supply chain network structure

Seen from the perspective of the focal company, three different relevant supply chain parts – *supply side, production* and *demand side* – can be identified in a supply chain product flow going *from natural resources to end market.*

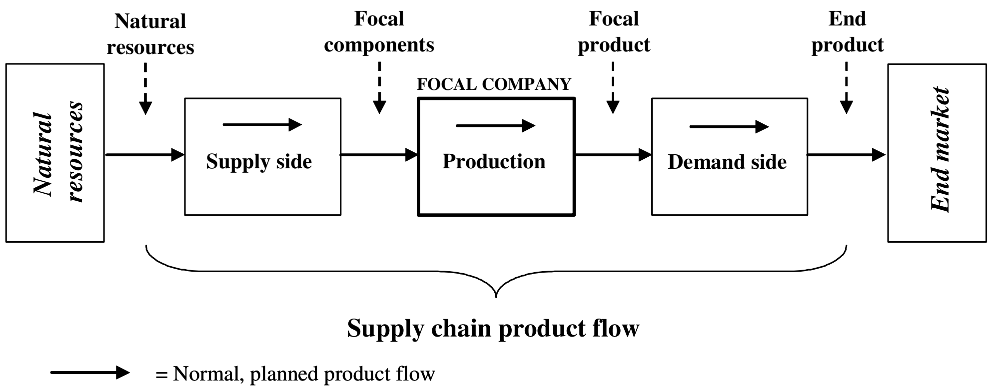


Figure 2.5: Supply chain network structure model – Level 3

2.3.2 Supply chain risk essentials

The supply chain risk essentials model identifies that in the supply chain which is of special significance from a disruption risk point of view. The model consists of six different supply chain risk essentials: *product design, production process design, product flow design, product flow supporting systems, risk management systems and actions,* and *human resources.*

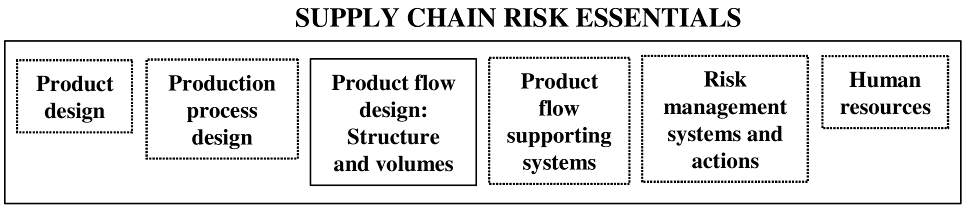


Figure 2.6: Supply chain risk essentials model – Level 3

2.3.3 Supply chain disruption source and post-event handling way structure

Earlier (figure 2.1) *two different ways of post-event risk handling* have been identified: internally handled, and passed on.

But the consequences of a disruption can often spread over long times. Another aspect is that they can unfold over time from local to widespread. And finally the consequences can change character over time. It is therefore important to split up the consequences into sub-groups. Those aspects seem to be especially relevant for the passed on disruptions. It is therefore suitable to split up the market reactions on several periods of time. Taking the critical event (disruption) as the starting point, the following three periods of time are chosen; *until back to a stable flow, short run, and long run*. Short run is also called market patience and another word for long run is market confidence. Consequently there are *four ways of post-event risk handling*: internally handled, passed on-until back to a stable flow, passed on-short run, and passed on-long run.

Three different *disruption sources* can be identified depending in where the initiating event takes place: within the supply side, within the focal unit, and within demand side. There are thus twelve possible combinations of disruption sources and post-event handling ways, which give us a certain disruption source and post-event handling way structure.

Table 2.1: Supply chain disruption source and handling way structure – Level 3

Scenarios structured after disruption source	**Post-event handling** structured after way of handling: Internally handled	Passed on – until back to a stable flow	Passed on – short run	Passed on – long run
Within the supply side				
Within the focal unit				
Within the demand side				

2.4. Risk management process; the risk analysis phase

A risk management process consisting of three "phases" – *risk analysis, risk evaluation,* and *risk reduction/control* – including eight "steps" altogether can be identified on the basis of IEC (1997).

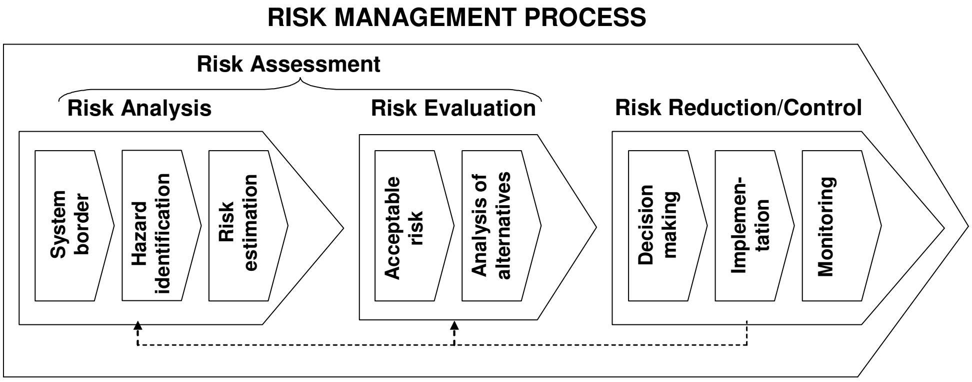


Figure 2.7: Risk management process model (based on IEC, 1997) – Level 2

Here our focus is only on the risk analysis phase. The risk analysis phase (Level 3) consists of the following three steps: *system border, hazard identification* and *risk estimation*. The latter is in the DRISC model more precisely expressed as *risk exposure estimation*.

2.4.1 System border

The first step when using the DRISC model is to decide on the setting, which means: *decide who is the stake holder and who is judging, choose focal unit and focal product, decide projects goals, specify measure dimension for result impact, specify time period, ambition level and time horizon,* and *decide other specifications/limitations*.

2.4.2 Hazard identification

The hazards are mapped within a structure that is a combination of two earlier presented models; the supply chain network model and the supply chain risk essentials model. The output from the model is information about potential vulnerability sources and about risk management activities.

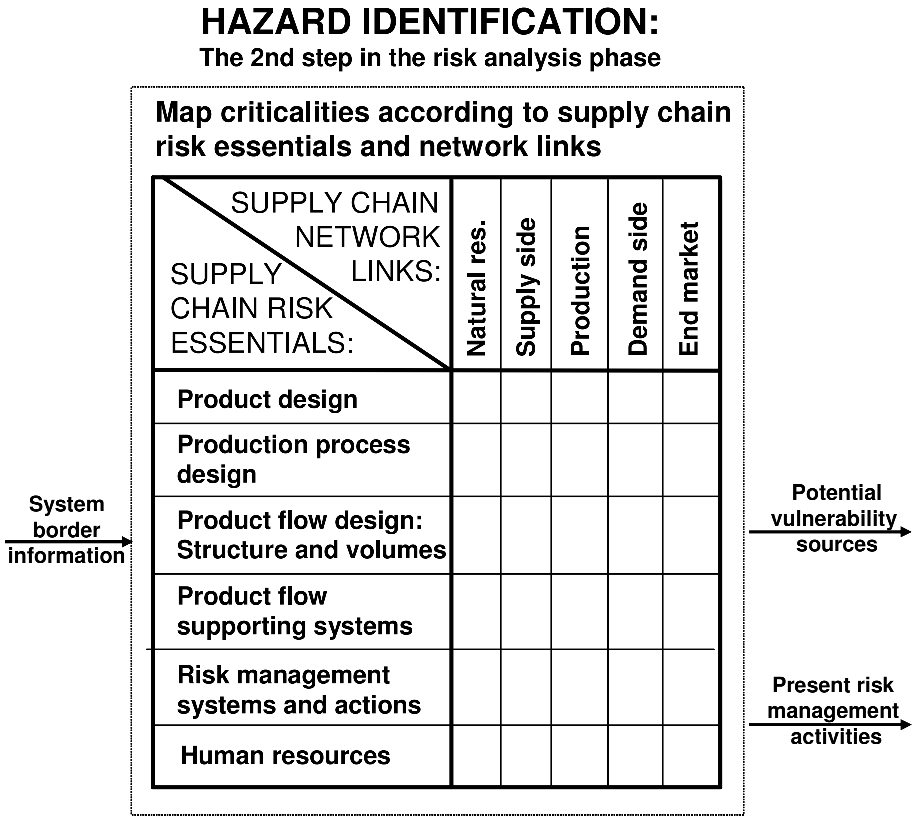


Figure 2.8: Hazard identification model – Level 4

2.4.3 Risk exposure estimation

The risk exposure estimation model consists of *risk exposure box structure* and *estimation of the result impact*. The output from the model is information about estimated result exposure.

The *risk exposure box structure* is based on the disruption source and post-event handling way structure presented earlier (Table 2.1) complemented with pre-event handling. Each preventive measure can be linked to one or more of the same three disruption sources as the post-event handlings were. We will then get 3 new boxes making a total of 15 boxes.

Acting in advance by taking preventive measures causes negative result impact. Those "costs" will be called "known result impact" since we know that they will occur.

Acting after the disruption has happen also causes "costs". Those costs will be called "expected result impact", since we do not know if the disruption is going to occur or not. Finally if we sum up known negative result impact and expected negative result impact we will get the *total negative result impact from the disruption risk exposure.*

In theory the complete result impact for each of the 15 risk exposure boxes can be estimated. They can then be summed up into a complete total negative result impact. In practice this is seldom done because it is practically impossible, or because such exact information is, from an action perspective, not necessary. A possibility is to use *a limited set of risk levels*. We will then acquire *a rough estimate of the result impacts*. This is a timesaving method, and if the aim is to gain a quick overview of the risk situation in a supply chain, using risk levels is probably a practicable method.

Table 2.2: Risk exposure; Box structure – Level 5.

	Known NRI from preventive measures		Expected OUTCOME structured after way of risk-handling:					*NRI FROM DISRUPTIO N RISK EXPOSURE*
			Expected RI from *internally handled* disruptions	Expected RI from passed on disruptions upstream/downstream with includation of market reaction and considering time dimension				
DISRUPTION SOURCE:				until back to a stable flow	in the short run (market patience)	in the long run (market confidence)		
Initiating event within supply side		AND					EQUALS	
Initiating event within focal unit		AND					EQUALS	
Initiating event within demand side		AND					EQUALS	
			Total expected RI from internally handled	Total expected RI from passed on; Until back to a stable flow	Total expected RI from passed on; In the short run	Total expected RI from passed on; In the long run		
	TOTAL KNOWN NRI	AND	**TOTAL EXPECTED NRI**				EQUALS	*TOTAL NRI*

For the estimation of the result impact is the question of *objectivity* central. Objectivity is desirable but could be difficult to reach. In some situations, risks are well defined and we have accurate data for both consequences and likelihood. The calculated expected value of the risk in those situations can be said to be objective or reasonably objective. But there are also many situations where information is insufficient or lacking and we have to rely on *subjective estimations*. The estimations ought to be made by experts either within the focal unit, such as risk managers, production managers and others within the company, or external experts, like risk consultants. Each estimation should be accompanied by *motivations*. The motivations can be as interesting as the estimation itself.

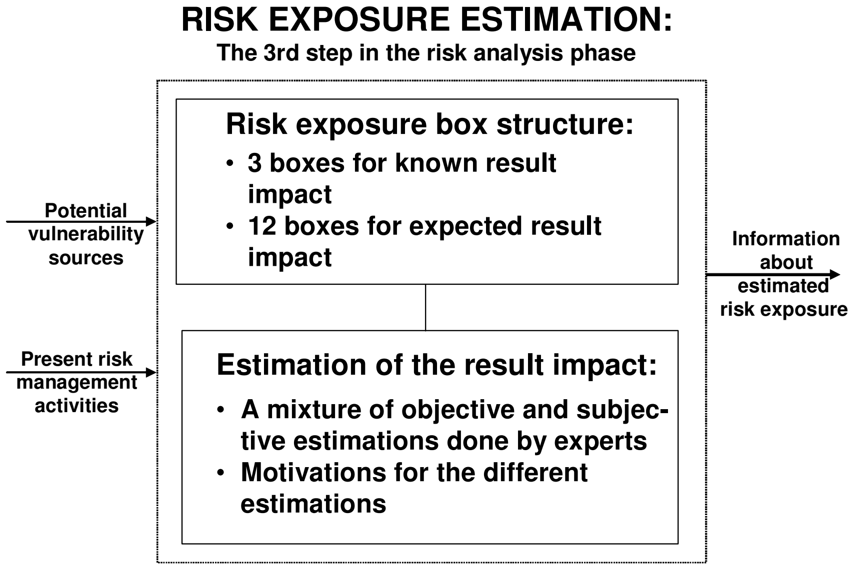


Figure 2.9: Risk exposure estimation model – Level 4

2.5. Risk management process; the risk evaluation phase

Risk evaluation is the second phase in the risk management process and consists of two steps: acceptable risk and analysis of alternatives.

2.5.1 Acceptable risk

Acceptable risk is the fourth step in the risk management process and the first in the risk evaluation phase. Now that the risk analysis phase is completed and the system borders are set, the hazards identified and the risk exposure estimated, it is time to decide which risks are acceptable and which are not.

If a specification of the level of acceptable risk has already been set in the system border step, that specification is to be applied. If not, it is time to draw up the specification now. Then we compare the set level with the estimated result impacts in order to find out which risks are not acceptable and where we thus have to search for better alternatives. The output from the model is a list of the non-acceptable risks and the information about estimated result impacts from the previous step.

2.5.2 Analysis of alternatives

After having identified what specifies the non-acceptable risks, we now try to find new acceptable alternatives by choosing one or several risk handling methods and applying them on one or more supply chain risk essentials.

Identify what is critical

Looking more closely at the risks, we often find that a few scenarios represent almost all the total negative result impacts. This means that if those scenarios can be identified, our efforts can be concentrated on them, thus substantially reducing the complexity of the problem without losing too much accuracy. Approximately how many alternatives should be considered also has to be specified.

Generate alternatives

To generate a new alternative means to choose a risk handling method to use and a (or several) supply chain risk essentials to change. The different supply chain risk essentials were presented in the supply chain risk essentials model (Figure 2.6) and will not be further commented upon here.

The list of generic risk handling methods was developed in three steps, first general risk strategies (Borge, 2001), then company risk strategies (Deloach, 2001), and finally supply chain risk strategies (Jüttner et al., 2003; Lindroth & Norrman, 2001). The result was a list of 22 strategies — or generic risk handling methods as they were called — to choose from. The list is presented below. Each risk handling method is linked to the part or parts of the risk triplet (Kaplan, 1997) – scenario, likelihood and/or consequences –affected.

Table 2.3: The generic risk handling methods linked to affected triplet element.

Generic riskhandling methods	
	Affected triplet element/s
1. Accept	
2. Avoid	Scenario
3. Back-up plans	Consequences
4. Buffers	Likelihood
5. Concentrate	Scenario and Likelihood
6. Create/increase	Scenario
7. Diversify	Consequences
8. Flexibility	Consequences
9. General reserves	Consequences
10. Good relations	Consequences
11. Identify	Consequences
12. Insure	Consequences
13. Organize	All three
14. Overcapacity	Consequences
15. Protect	Scenario
16. Replace	Consequences
17. Secure supply chain partners	Likelihood
18. Training	All three
19. Transfer through contract changes	Consequences
20. Quality assurance	Scenario
21. Quality check	Scenario
22. Quantify	Consequences

A short description of risk handling methods 1–4 in Table 2.3 by way of illustration:

- *Accept* means changing the "all triplets definition" so that it will include fewer triplets than before.
- *Avoid* could mean that the "system specification" is changed in such a way that the number of triplets is reduced or totally eliminated.
- *Back-up plans* could mean that the consequences of a potential disruption become less severe.
- *Buffers* could mean that fewer disruptions than before will lead to negative consequences.

The different individual risk handling methods presented above are all proactive in the sense that they can be decided upon before there is a disruption. In Paulsson 2007, Appendix 4, examples of individual risk handling approaches are given for each of the generic risk handling methods.

2.5.3 The analysis of alternatives model

Input to the model is information about *estimated risk exposure* and *the non-acceptable risks*. Output from the model is information about c*onsidered risk handling alternatives*. When considering if the risks could be handled in a better way in the future, we first need to decide what is critical and approximately how many alternatives should be considered. A risk-handling alternative is presumed to consist of two parts; a chosen risk handling method and chosen element/s to change. Each method affects one or more of the risk elements. In total, 22 generic risk handling methods and three affected risk elements have been identified. Summing up the discussion above ends up in the following analysis of alternatives model.

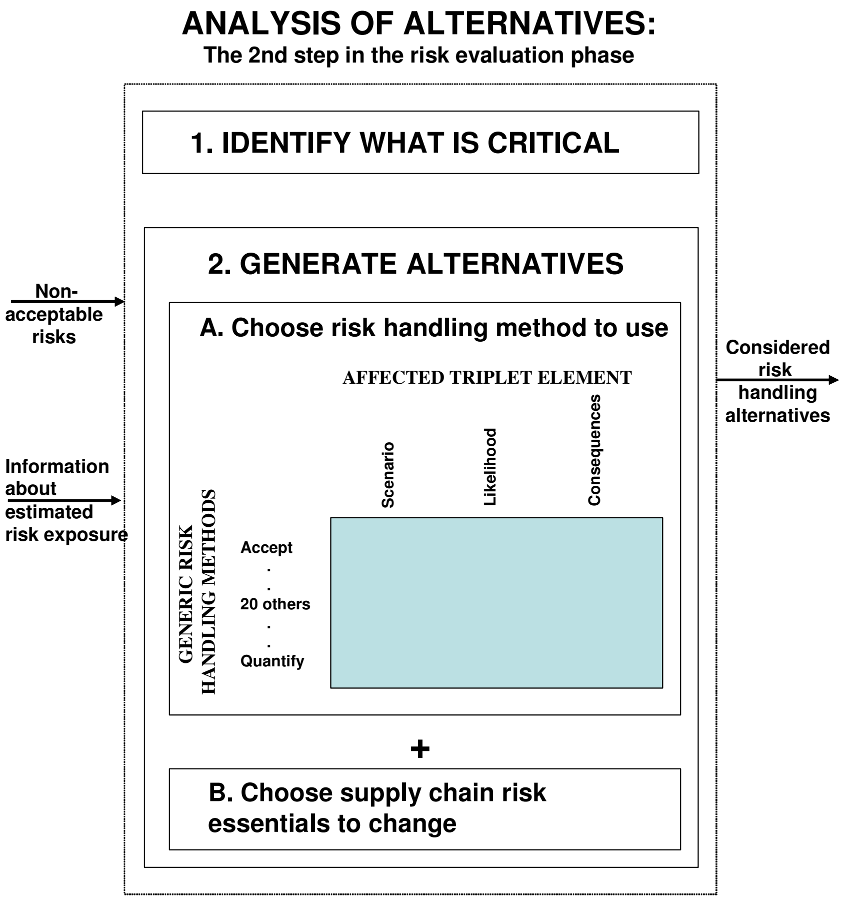


Figure 2.10: Analysis of alternatives model – Level 4.

3. V&S Sundsvall AB

The substance of this and the following chapters is mainly based on general written information about the company, a personal visit to the premises, including an interview with the quality manager in August 2006, two other reports within the SIK project (Arinder & Milanov 2007; Janson 2007) and recurring discussions with representatives of the company via e-mail, telephone and face-to-face at SIK-project meetings.

3.1. The company – some basic facts

V&S Vin & Sprit AB is the mother company in the V&S Group. The group is divided into three different business areas: V&S Absolute Spirits, V&S Distillers and V&S Wine. With the exception of the Blossa mulled wine assortment, which is part of the "Wine" division, the Sundsvall site belongs organizationally to the "Distillers" division.

The products of the Sundsvall site are the traditional Swedish alcoholic beverages, for example schnapps, gin, vodka (except for Absolut), cognac, Swedish punch (arrack) and liqueur, but also certain traditional wines with high alcohol content and the entire Blossa assortment.

It is almost exclusively Swedish consumers that are addressed. Today, the market consists of the Swedish market via Systembolaget (for light mulled wine via the food chains) and, to a certain extent, borderline trade aimed at Swedes. IKEA has joined recently and is now selling certain V&S products in their department stores abroad. In 2005, for example, IKEA sold the products Vinglögg (mulled wine) and Trestjärnig glögg (Three-star mulled wine) with rum flavor, but in Sundsvall it is hoped that they will include more products in the future.

The most important single "raw material" is fine alcohol. 96% fine alcohol is produced if you take raw alcohol and distil it to eliminate ethanol and higher alcohols. The price level is SEK 6-10 per liter. The V&S Group includes, among others, Gärdsbränneriet outside Kristianstad, where fine alcohol is produced. According to a policy decision within the Group, however, all the fine alcohol produced at Gärdsbränneriet outside Kristianstad is to go to Åhus for the production of Absolut vodka. Consequently Sundsvall has purchased its fine alcohol from Lidköping in the last few years, but other alternatives are being considered.

Around the mid-90s, the share of non-returnable bottles increased at Systembolaget, since their new suppliers' imported products into Sweden that had already been bottled. This turned out to be a competitive disadvantage for V&S. In addition, the Swedish prohibition against marketing alcoholic beverages had made it even more important to make one's package visible, i.e. to have a package that attracts attention. V&S then decided to discontinue the system of returnable bottles, which made it possible for each product in the V&S assortment to have its own unique bottle.

Culminating around the shift of the millennium, a unique bottle, cork and label design was created for practically every single product in the assortment. Boxes and similar things were also made unique to the individual product. All this resulted in a swift increase in the assortment of input goods. This gradually came to be regarded as too expensive, and today the trend is towards a higher degree of standardization.

Systembolaget's introduction of an increasing number of self-service stores has made people more interested in trying new products, which has also to some extent been a disadvantage for V&S, since they are the ones who produce the old traditional brands.

3.2. The product assortment

3.2.1 The total assortment

After Årsta, Falkenberg and other sites have been closed down, and except for Århus where Absolut is produced, the Sundsvall site is now the only production place owned by V&S in Sweden. This means that the Sundsvall site produces, for example: vodka (e.g. Explorer), aquavit (e.g. Skåne, Hallands fläder (elderberry schnapps), OP, vintage schnapps), cognac (e.g. Grönstedts, Armagnac, Eau-de-vie), punsch (e.g. Carlshamns flaggpunsch), liqueurs (e.g. cacao liqueur), whisky (e.g. Standard Selection), wines with a high alcohol content (Rosita, Taverna, Körsbärsvin (Cherry wine) etc.) as well as mulled wine (the Blossa assortment).

Even though these are all mainly traditional products made according to well-tested recipes, certain changes have been made here as well. Some products, OP for example, are now made with KRAV-marked raw materials. But new products are also being developed. The production of different kinds of vintage mulled wine has been a great success, as has the launching of a new Scotch whisky called "Moore".

3.2.2 The Blossa assortment

Nowadays the Blossa assortment consists of, for example, Blossa vintage mulled wine (from 2001 and onwards), Blossa Trestjärnig glögg (Three-star mulled wine with rum), Blossa trestjärnig glögg with cognac, Blossa mulled wine 15% (red and white), Blossa mulled wine 10% (also packaged in Bag-in-box in Sundsvall and in tetra in Germany) and Blossa light mulled wine 2.2% (red and white).

Due to its low alcohol content, the latter product runs a higher risk of contamination than the other products. This is one of the reasons why the focus will be on this will be in focus in what follows.

3.3. The product Blossa lättglögg

Wine and liquor are food products. In Sweden, due to Swedish legislation, they are distributed via Systembolaget except for light mulled wine. Blossa lättglögg has such a low alcohol content that it can be sold via the usual food chains, such as ICA, COOP etc.

The low alcohol content, 2.2 %, of light mulled wine places higher hygienic demands on the production process than do alcoholic beverages and wine with a high alcohol content. Consequently, an attempt is made to separate the production of light mulled wine from other production in order to reduce the risk of some kind of contamination infiltrating the production of light mulled wine.

When the Falkenberg site was closed down, the production of mulled wine was moved to Sundsvall. The two most important ingredients in mulled wine are basic wine (normal wine) and mulled wine alcohol (which is then refined into spiced wine before being used in the production of mulled wine). There is no fine alcohol in Blossa lättglögg. The alcohol is added via the mulled wine alcohol plus the small amount that is left in the basic wine.

The wines for the mulled wine must come from EU countries, since the mulled wine cannot otherwise be defined as mulled wine and/or mulled wine with a higher alcohol content. The basic wine is imported from Spain, among other countries. The red mulled wine requires wine from red grapes and the white mulled wine requires wine made of white grapes. It is important that the basic wine for white mulled wine is sufficiently light, since it cannot be made lighter in the production process. Moreover, uncolored glass is used for the bottles of white mulled wine. Red mulled wine, however, can be made darker if need be, and dark glass is also used for the bottles. It is also possible to make mulled wine on the basis of other material than wine like fruit juice, which is done by Saturnus for example. Mulled wine is a typical seasonal product that is almost exclusively sold during November and December.

The mulled wine alcohol can be said to be the basis of all the Blossa products. The path of mulled wine alcohol is as follows: Spices (ginger, cloves etc.) arrive at Åhus. The purchasing process takes place once a year, the entire process taking about three months. The spices are extracted for about one month in alcohol, and then matured for one to two months. The result, mulled wine alcohol, is then sent to Sundsvall, where it is mixed with wine and matured for another ten weeks. The result is spiced wine (mulled wine alcohol).

Light mulled wine – raw materials

- Basic wine, red or white
- Mulled wine alcohol (to create mulled wine)
- Liquid sugar
- Sugar coloring to obtain the right coloring
- Preservatives (sorbine acid and sulphur dioxide)
- Bottle
- Cap
- Label (for vintage mulled wine screening of the bottle itself)
- Carton/collar with print
- Whole, half or quarter pallet
- Water
- Electricity

Except for the basic wine, one supplier delivers most of the input goods only. The basic wine, however, is purchased from about three different suppliers. The reasons for this are that a more homogeneous wine can be produced, that most suppliers are small and are not able to deliver the entire volume and that, if there are several suppliers, a certain competition arises among them.

The water used is municipal and of high quality. It is used for three different purposes: 1) to dilute the products, 2) to rinse the new bottles and 3) to clean tanks, floors etc. In the first two cases the water is first distilled by reversed osmosis.

3.4. The product flow of Blossa lättglögg

3.4.1 At the supply chain level

In Chapter 2, a figure (Fig. 2.5) of the supply chain network structure was presented. This figure will be used here as a basis for the presentation of the supply chain flow of V&S.

Natural resources
Nature in the sense of natural resources here mainly refers to those natural resources in the form of sand, for example, that are required to produce glass, wood/paper pulp for boxes and farming land for the production of wine.

Supply side
The wine comes directly from the producers to the Sundsvall site, as do bottles, caps and carton packages. The water comes from the municipal water works and the electricity from the ordinary electricity network. These are all relatively uncomplicated chains of refinement with uncomplicated products and fairly brief refinement times. The mulled wine alcohol is different, however, since it requires a refinement process of several months and because it contains a number of spices.

Production
The Sundsvall site, V&S.

Demand side (distribution)
The company sells its Blossa lättglögg products mainly in Sweden through the big grocery chains like ICA and COOP.

End market
End customers are mainly the different individual consumers (private households) that buy Blossa lättglögg in the shop.

3.4.2 At the factory level

Light mulled wine – the production process
Whereas Blossa lättglögg used to be produced the year round, it is now only produced during the period May – November, which means that the time margins to capture potential disruptions have been reduced. It also means that a substantial supply of

mulled wine must be produced in order to meet the brief and intense period of demand.

The basic wine, which is kept in a so-called flexi bag of 24 cubic meters inside a container that provides the outer protection, arrives by ship at the Sundsvall harbour, is lifted over to a truck and driven to the plant, where it is pumped into one of the tanks of 24 cubic meters. The mulled wine alcohol is also kept in 24 cubic meter tanks.

After that, the alcohol is removed from the basic wine in a so-called column with a capacity of 750 liters per hour. There is only one column. Then the basic wine is pumped into a tank where the other ingredients are added, and the mixture is stirred for about two hours. This mixture is then pumped into another tank to be stabilized. During the stabilization process, the tank is kept at 16 degrees to reduce the risk of bacteria growth. After that the mixture is filtrated to remove cloudiness: an amount that will not bother the consumer esthetically is filtered away, but not too much since the cloudiness contains aroma particles. After that, it is a matter of keeping a balance between flavor and appearance. Prior to being bottled, the mulled wine is pumped into tanks on the second floor in direct connection with the packaging line. These tanks are also kept at 16 degrees.

Pumping from one tank to another is partly done by means of fixed pipe installations about one meter up in the air but partly also by means of loose hoses resting on the floor and pulled by hand from tank to tank. The same CIP (Clean-in-place) system is used for all the products today.

Light mulled wine – the bottling process
Bottling takes place in a large two-story building. The incoming stock of packages is kept on the ground floor. The empty bottles are transported to the second floor by means of an elevator that is part of the packaging line. There they are unpacked, rinsed clean, filled, capped, labelled, inspected and packed in a box. The boxes are then taken down to the ground floor in another elevator and temporarily stored before cleared by inspection. Samples to check alcohol content, bacteria content etc. are taken from every single bottled batch. The batch cannot be released until inspection has given the go-ahead after establishing normal values in the samples.

The normal bottling time for a batch is three to eight hours. Changeover time between different batches is about one hour. In total there are six different packaging/bottling lines. Line 6 is a short, simple line intended for bag-in-box products (two litres of mulled wine, for example). Line 5, which is fairly new, is used for Blossa products and is antiseptic. At present it is partly built-in, and there are plans for building it in even more. Lines 1 to 4 are used for the remaining assortment.

The various products in the Blossa assortment are kept in stock in Sundsvall, and all the remaining products in the V&S central stock in Stockholm.

4. Mapping and evaluating the disruption risks for Blossa lättglögg

The risk analysis phase consists of three steps – system border, hazard identification and risk exposure estimation. For each step a model has been developed.

4.1. System border specification

The system border model, which was presented in the form of text in section 2.4.1, will now be applied on V&S.

The f*ocal unit* is V&S, the Sundsvall site and the *focal product* is Blossa lättglögg. The *project goal* is to map and evaluate the risks and to propose new risk handling alternatives.

4.2. Hazards identification and risk evaluation

The hazard identification model was presented in Figure 2.8. That model is now applied here. The aim of the mapping is to collect information about potential risk vulnerability and to identify present risk management activities.

4.2.1 Disruptions from supply side

Hazards

<u>Electricity</u>

• Electricity. There is only one supplier and no spare aggregate. Can, however, cause minor disruptions only.

<u>Water</u>

• Municipal water is taken in via three different pipes, but comes from the same source.

<u>The bottle</u>

• Since last year, the light mulled wine has been bottled in a special, unique bottle with "Blossa glögg" etched in the glass. This new design has been positively received.

• V&S own the bottle design and the moulds, but the moulds are physically located with the bottle producer.
• The bottles are produced by Rexam in Denmark. There is only one supplier. In Sundsvall there is a stock of empty bottles on hand for about one week's production.
Mulled wine alcohol
• Mulled wine alcohol can be said to be the basis of all Blossa products. There is only one supplier (Åhus).

Risk exposure levels
It is mainly the mulled wine alcohol that is critical in the delivery process. There is only one supplier – Åhus. In addition, the mulled wine alcohol seems to be the input goods that has the longest lead time – about three months for the purchasing process and about two-three months for the production process (plus around ten weeks internally in Sundsvall). What happens if something goes wrong in Sundsvall at a critical moment? If, for example, the stock at the Åhus site is burnt down at exactly the time when the mulled wine alcohol is to be delivered from Åhus to Sundsvall?

The unique bottle is also a critical factor in the delivery process. What happens if the bottle producer's plant, including the moulds for the Blossa glögg bottle, is totally destroyed in combination with the fact that there is only one supplier and a stock on hand that will cover about one week's needs? Strictly technically speaking, it is possible to use other bottles, but how will the market react to that?

Preventive measures = medium
Mainly the costs for keeping buffers in stock, i.e. about one week's buffer stock of bottles. Less extensive stock of the basic wine plus other packages. Stock for an entire season of the mulled wine alcohol. There is a substantial stock of finished products (Blossa lättglögg), up towards meeting the demands during an entire season, which is mainly for reasons of production, but this stock can to some extent also be regarded as a buffer.

Internally handled = low
The substantial stock of finished products will take care of most of the disruptions in in-deliveries. Reducing the stock of finished products is not, however, an ideal solution. There are also certain possibilities to re-plan production and to have staff work overtime, which involves increased costs.

Exported – Until disruption ends = low
The substantial stock of finished products takes care of most disruptions in in-deliveries. Nevertheless, a long-term lack of mulled wine alcohol at a critical stage can result in problems of delivery. Delivery disruptions lead to lost income. A long-term lack of the specially designed and unique bottle may involve having to resort to standard bottles instead, which means that individual customers may annul their orders or claim a reduced price.

Exported – Short run (market patience) = low
A potential delivery disruption will probably have a certain backlog effect, i.e. it will be some time before demand is back at a normal level again. In the same way, a forced transition to standard bottles may lead to a reduced demand. In both cases, this results in reduced income.

Exported – Long run (market confidence) = low
Repeated delivery disruptions make the market lose confidence in V&S as a reliable supplier and lead to lost market shares and, consequently, a loss of future income.

4.2.2 Disruptions from within production

Hazards
Mulled wine alcohol
• In the course of ten weeks of storage and maturing, the mulled wine alcohol is transformed into mulled wine. What will happen if something goes wrong during this maturation process?
Column
• The alcohol is removed from the basic wine in a so-called column. The only existing column has a low capacity (750 liters per hour). What will happen if the column breaks down?
Alcohol check
• Alcohol check, i.e. checking that the final product contains the percentage of alcohol stated in the declaration of contents, must function, since it is made obligatory by law – otherwise the product cannot be sold.
• Standard equipment that can be acquired fairly fast is likely to be used if the equipment at the site should malfunction.
Other production equipment
• Tanks, pumps, bottling machines, packaging machines etc.
• Standard equipment that can be acquired fairly fast is likely to be used if the equipment at the site should malfunction.
Contamination
• Contamination is a collective term for a number of different types of pollution.
• Contamination means that, somehow or other, pollutants enter into the future light mulled wine during the production process, thus ruining or deteriorating it.
• In most cases, contamination is discovered during the production process or at the final quality control, but under unfortunate circumstances they can remain undiscovered. As a result, a final product of insufficient quality is delivered to customers. This can lead to a cloudy, foul-tasting final product, or even a fermented one.
Fine alcohol

• No fine alcohol is used in Blossa lättglögg, but it is part of the remaining products in the Sundsvall site's assortment. The fine alcohol, which has a 96 percent content of alcohol, is easily ignited. Therefore smoking is not allowed where fine alcohol is handled, nor is the use of mobile phones or common electronic equipment due to the risk of sparks.
• The fine alcohol is mainly stored in large cisterns on the quay outside the building. A total of about two million litres of 96 % fine alcohol is stored, and if that is ignited there will be a violent explosion.

<u>Security</u>

• There are goods that are especially liable to be stolen. What are the risks of break-ins and stealing products, computers, recipes, industrial secrets etc.?
• The consequences of a break-in can lead to comprehensive damage or even total destruction of the entire plant. Some thirsty people, for example, break in, begin to drink and open the vents of tanks, which causes extensive damage. In the worst of cases, they open the vents of a tank that contains fine alcohol and accidentally ignite this with a cigarette – and the fire then spreads very fast.

<u>Totally destroyed plant</u>

• On the whole, what risks are there of a fire, an explosion, water damage etc. totally destroying the plant?

Risk exposure levels

Contamination is likely to be the greatest risk in the production of light mulled wine, and it is sometimes necessary to reject large amounts of it. It can be especially serious if the fault is not detected at the final quality check and the product reaches the consumer. In addition to the costs incurred by having to withdraw products, fermented mulled wine may result in significant bad will effects. The issue of *contamination risks* and how to handle them is specifically dealt with in two other reports within the SIK-project (Arinder & Milanov, 2007; Janson, 2007) and is therefore not focused in this report.

The *mulled wine alcohol* is also vulnerable due to the long lead times in combination with the fact that the maturation process takes place in one place only and that the basic mulled wine is the basis of the light mulled wine.

The *column* is crucial, since there is only one and it has a limited capacity. It is possible, however, to purchase wine from abroad where the alcohol has been removed.

The *entire plant*, finally, may also be regarded as vulnerable, since the various sections are combined into one single, large building and since highly inflammable liquids (96 % fine alcohol) are stored in large quantities.

<u>Preventive measures = low</u>

There is a substantial stock of finished products, which has been created for reasons of production.

Internally handled = low

The substantial stock of finished products takes care of most disruptions in production, but reducing this stock is not an ideal solution. There are also certain possibilities to re-plan production and to do overtime work, which involves increased costs.

Exported – Until disruption ends = medium

The substantial stock of finished products takes care of most disruptions in production. Nevertheless, if the maturation process where mulled wine alcohol is transformed into basic mulled wine fails, or if there is a fire or something else that eliminates the stock of mulled wine alcohol/basic mulled wine, this may lead to a long-term lack of basic mulled wine, which, in turn, can result in delivery problems at a critical stage. Interrupted deliveries and quality flaws both result in lost income.

Exported – Short run (market patience) = high

A potential interruption in deliveries will probably have a certain backlog effect, i.e. it will be a while before demand is back at a normal level again. Customers have probably not waited, but are likely to have bought another brand instead and may already have got accustomed to the competitor's product.

Exported – Long run (market confidence) = very high

Repeated interruptions in deliveries result in a reduction in customers' confidence in V&S as a reliable supplier, long-term lost market shares and, consequently, a loss of future income. Having to withdraw products due to quality flaws that have been discovered in retrospect is even worse, since this may lead to significant bad will effects among final consumers.

Furthermore, it should be added that if something of a negative nature happens to Blossa lättglögg, e.g. that contaminated mulled wine reaches the consumers; the bad reputation caused by this incident may "infect" the entire Blossa concept. The Blossa glögg brand could be seriously damaged.

4.2.3 Disruptions from demand side

Hazards and Risk exposure levels

No specific demands are placed on the temperature of, for example, storage of the product. Sales/distribution are handled by Systembolaget and the big food chains, the latter being used to distributing liquid food products. Moreover, the stock of products is spread out over many different customers' Distribution Centers and stores, respectively. All this taken together means that the combined risk exposure levels have been judged as very low.

4.2.4 Summing up the risk exposure levels

Table 4.1: V&S; Risk exposure levels for Blossa lättglögg

Blossa lättglögg					
	***RISK COSTS, ways of handling* and time dimension:**				
	KNOWN RISK COSTS for *preventive measures*	**EXPECTED RISK COSTS for *internally handled* disruptions**	**EXPECTED RISK COSTS for *exported* disruptions upstream/downstream with consideration of market reaction**		
DISRUPTION SOURCES:			**until the disruption ends**	**in the short run (market patience)**	**in the long run (market confidence)**
Disruptions from supply side (no components, raw material or similar)	**Medium**	**Low**	**Low**	**Low**	**Low**
Disruptions from within production (production break-down)	**Low**	**Low**	**Medium**	**High**	**Very high**
Disruptions from demand side (no orders)	**Very low**	**Very low**	**Very low**	**Very low**	**Very low**

Risk cost levels; Very low, Low, Medium, High, Very high and Not estimated.

5. Ideas for improvements in the risk handling of Blossa lättglögg

5.1. Individual suggestions for alternative risk handling

This section is structured after ”The analysis of alternatives model” (Fig.2.10), which has two main parts – ”Identify what is critical” and ”Generate alternatives”. The latter is split into two steps; A/ Choose risk handling method to use, and B/ Choose supply chain risk essentials to change. A list of 22 generic risk handling methods was presented in Table 2.3, and 6 different supply chain essentials were presented in Figure 2.6. The essentials were: product design, production process design, product flow design, product flow supporting systems, risk management systems and actions, and human resources.

A number of individual suggestions for alternative risk handling will be presented below. They are based on Table 4.1, where the risk picture for Blossa lättglögg was charted and where the critical risks are focused upon. Each risk-handling alternative suggested is linked to a generic risk-handling method and to a supply-chain risk essential. One and the same risk-handling alternative can often be classified under different risk-handling methods and, similarly, under several different risk essentials. Here, however, one risk essential only, namely the one that has been considered most relevant, will be indicated.

Accept

- Accept the disruption risks that exist at the present time.

Avoid (totally or partly)

- Stop producing Blossa lättglögg.
- Product design: Make changes in products in terms of bottles, caps, labels and boxes by using more standard variants, for example.
- Product design: Make changes in products in terms of the composition of the mulled wine itself by replacing the mulled wine alcohol by artificial extracts, for example.
- Production process design: Create a closed production process with fixed pipe installation for Blossa lättglögg exclusively.

Back-up plans (contingency plans)

- Risk management systems and actions: Design a reserve plan for interruptions in in-deliveries of mulled wine alcohol, for example in terms of a list of what alternative suppliers are available and perhaps also in terms of a contract with an alternative supplier who promises to step in at short notice.

- Risk management systems and actions: Ditto for bottles/caps/boxes.
- Risk management systems and actions: Design a reserve plan for disruptions in the column that specifies from where and on what terms (delivery time, price etc.) basic wine where the alcohol has been removed can be purchased abroad.
- Risk management systems and actions: Create a reserve plan in terms of a program of measures to be taken when contamination has occurred, for example routines for withdrawing products and ways of informing customers and the public.
- Risk management systems and actions: Design a reserve plan for measures to be taken if the production plant/factory were to be destroyed, for example by investigating and choosing alternative production plants and production methods in advance.

Buffers

- Product flow supporting systems: Start production earlier.
- Product flow design: Increase the buffer stock of bottles, caps, labels and boxes.

Concentrate

- Production process design: Move the production of mulled wine alcohol from Åhus to Sundsvall.

Create/increase

- Product flow design: Skip the buffer stocks of input goods.

Diversify

- Product flow design: Disperse production over several plants.
- Production process design: Acquire another column.
- Product flow design: Split up the purchase of mulled wine alcohol.
- Product flow design: Disperse the storage of mulled wine alcohol/wine over several locations.
- Production process design: Create copies of the bottle moulds and keep these in other places than at the supplier's.
- Product flow design: Move either production or stocks, so that they are not located in the same complex of buildings.
- Product flow design: Disperse production over several separate buildings with considerable safety distances between them.
- Product flow design: Use more geographically dispersed production units, i.e. in different locations.

Flexibility

- Product design: Make sure that the special variants of bottles, caps, labels and boxes keep the same outer measurements as the corresponding standard variants.
- Production process: Increase the adaptability of machinery in order to facilitate a potentially necessary transition to standard bottles, caps and boxes.

General reserves

- Risk management systems and actions: Deposit money in the balance sheet for a special reserve fund for risks of disruptions.

Good relations

- Human resources: Build up good relations and cooperation with suppliers and customers.
- Human resources: Build up good relations and cooperation with colleagues in the same business.

Identify

- Risk management systems and actions: Conduct risk analyses focusing on identifying risks.

Insure

- Risk management systems and actions: Survey insurance possibilities.

Organize

- Risk management systems and actions: Introduce/adapt monitoring system.
- Risk management systems and actions: Introduce/adapt early warning system.
- Risk management systems and actions: Introduce/adapt traceability system.
- Human resources: Clarify issues of responsibilities concerning disruption risks.

Overcapacity

- Production process design: Purchase another column.

Protect

- Risk management systems and actions: Increased security control.

Replace

- Risk management systems and actions: In case of disruptions in the in-deliveries of bottles, caps or boxes, go over to standard variants of these.
- Risk management systems and actions: In case of disruptions in the in-deliveries of mulled wine alcohol, go over to artificial extracts.

Secure supply chain partners

- Risk management systems and actions: Check and make sure that the risk level is acceptable to the supplier of mulled wine alcohol, i.e. V&S in Åhus.
- Risk management systems and actions: The same procedure for bottles, caps, labels and packages.

Training

- Human resources: Regular training of staff in issues of security.

Transfer through contract changes

- Product flow supporting systems: Write contracts where the supplier takes increased responsibility for the consequences of delivery problems, for example.

Quality assurance

- Risk management systems and actions: Quality assurance of suppliers and production processes.

Quality check

- <u>Risk management systems and actions:</u> Quality check of incoming components, of the production process and of the finished product.

Quantify

- <u>Risk management systems and actions:</u> Quantification by means of a more thorough risk analysis of critical risks and risk areas.

5.2. The critical risk factors and the new alternatives

The mulled wine alcohol

Mulled wine alcohol is a critical risk factor, since it is a very important input goods, it is single sourced and the lead time for producing the finished mulled wine is several months. In addition, it is probably difficult to find alternative suppliers at short notice.

Several of the alternatives listed above are attempts to reduce or eliminate this risk. Going over to artificial extracts is one such suggestion, building up a buffer stock and dispersing the storage of the mulled wine alcohol over several physically separate places are others. And it is naturally important to have a reserve plan ready to be used in case of a disruption.

The unique package

The bottle and the remaining parts of the package all have their own unique design and are single sourced. Since the bottle and the other parts of the package are important sales attributes today, this means that the package is a critical risk factor.

This risk can be reduced e.g. by making sure that several copies of the production mould are dispersed over physically different places, by having a large buffer stock of bottles, by being prepared for a swift transition to standard alternatives and by having a reserve plan ready to be used.

The column

The column is a critical risk factor due to its low capacity in combination with the fact that there is only one of them.

This risk can be reduced e.g. by installing another column, by starting up the production of mulled wine earlier and by having access to a reserve plan that specifies where wine where the alcohol has been removed can be purchased abroad.

Contamination

Contamination is another critical risk factor. With its low alcohol content, light mulled wine is vulnerable to pollutants. Under unfortunate circumstances, bacteria growth may occur, which may lead to a withdrawal of large numbers of bottles. But above all, it may lead to a reduction in the market's confidence in Blossa lättglögg and probably, to some extent, in other products in the Blossa assortment as well.

This risk can be reduced e.g. by building up a closed production plant for light mulled wine equipped with fixed installations only, by increasing quality checks and by having access to a reserve plan ready to be used.

6. Results

6.1. The objectives of the study

In Chapter 1, section 1.2, the following objectives for this study were identified:

- The *first objective* was to apply the risk analysis phase of the DRISC model on Vin & Sprit AB, the Sundsvall site, to map the disruption risks linked to the production of liquid alcoholic food products with a special focus on Blossa lättglögg.
- The *second objective* was to apply the risk evaluation phase of the DRISC model on Vin & Sprit Sundsvall to acquire ideas for possible improvements in the handling of those risks.
- The *third objective* was to gain experiences of the empirical usefulness of the DRISC model when doing supply chain disruption analyses in the liquid food production industry, and to obtain indications of suitable adjustments in the DRISC model.

6.2. The different results

Risk "picture"
A total of 11 of the 15 risk groups are estimated to have low or very low risk levels. Of the remaining four, two are estimated to have medium, one high and one very high risk levels. It is an important observation that the latter two are both generated internally within production and that those high values are mainly caused by contamination risks. Consequently, if these values are regarded as unacceptably high by V&S, they also have good possibilities of taking measures of their own in order to reduce them.

New risk handling alternatives
Between 40 and 50 new alternatives for risk handling were generated by means of "The analysis of alternatives model". Special interest was paid to those risk handling alternatives that were linked to one or several of the critical risk factors, namely the mulled wine alcohol, the unique package, the column and the risk of contamination. Three or more suggestions for alternative risk handling were generated for each one of these critical risk factors.

Risk model usefulness and risk model adjustments

The application of the DRISC model on the empirical case V&S, Sundsvall has illustrated the empirical usefulness of the DRISC model when doing supply chain disruption analyses in the liquid food production industry, both when mapping the risks and summing them up into a risk "picture", and when looking for new risk handling alternatives.

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V&S Sundsvall is a Swedish company producing different alcoholic beverages, mainly for the Swedish market.

In an earlier study (Paulsson 2007) a model for the structuring, evaluation and handling of risks related to disruptions in the product flow in the supply chain has been developed. The model makes it possible to classify and sum up the risks into 15 different risk exposure boxes. In another part of the model, new alternatives for handling those risks are generated with the help of a list of 22 generic risk handling methods.

At V&S Sundsvall a couple of risk boxes with a high risk level were identified. Based on this risk picture a list of some 50 different potential risk-handling alternatives was then generated.