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Managing supply chain risks and disruptions at an inland terminal with a focus on inter-organizational collaboration challenges

A case study at the inland terminal Alpherium in collaboration with Heineken.

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Master of Science Thesis

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Master of Science Thesis

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Preface

The moment has finally arrived. I am writing my preface as the final step of my thesis. It has been a rather challenging journey. Besides having to perform several analyses, I struggled with finding a suited structure for my report and combining two theses into one. Luckily, throughout my struggles I received support from friends, family and of course my committee. Before you lies the result of my thesis project, combining the Masters Transport, Infrastructure and Logistics and Science Communication at the TU Delft. This research was conducted at the Customer, Service & Logistics department at Heineken Nederland Supply (HNS) and the inland terminal Alpherium, part of NedCargo (formerly known as Van Uden). The research focuses on supply chain risk and disruption management at the inland terminal taking into account the characteristics of an inter-organizational collaboration between inland terminal and shipper. Although I had some trouble in the beginning of the project with combining the two masters into one research, looking back at the result, I strongly believe that TIL and social research are very complementary research fields. It is therefore, that the final result offers a fully integrated research, reflecting parts of both study fields. Luckily, this feeling was shared at my internship addresses.

I would like thank my daily supervisor at Heineken, Anette van Baal, for her numerous advices, support and patience throughout this process. She really helped me to stay focussed on the aim of this research, and not get distracted by everything else I thought I could address in my research. The times I spent at Alpherium were always pleasant, and I really want to thank Ivo Hilhorst and Jelle Steenbergen for providing me with a lot of useful information. I would also like to thank my first supervisors, Heide Lukosch and Steven Flipse, for helping me find a way to structure the great amounts of information I collected. I am also very grateful to Steven for not letting me give in to my uncertainties about the quality of my research. Of course I would like to thank Shijie Li, Maarten van der Sanden and Rudy Negenborn for providing me with valuable tips to improve the content of my report. And last but certainly not least; a special thanks to Alexander Verbraeck for helping me better understand the dynamics in my case study and how to relate these to the literature. From my personal environment I would like to thank Duncan Bender and Anne Blair Gould for helping me better phrase my intentions and for pointing out flaws.

Delft, University of Technology — K. Holzhauer
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A double degree thesis project

This report is part of an integrated thesis project combining the masters Transport, Infrastructure & Logistics (TIL) and Science Communication (SEC). Both fields are fully integrated in this project.

The TIL-perspective of this project focuses on Supply Chain Risk Management (SCRM) at an inland terminal. The specific focus lies on identifying and evaluating different supply chain risks and possible actions that mitigate these risks as well as dealing with supply chain disruptions. The motivation for the TIL-perspective stems from the growing importance of SCRM, due to several supply chain trends as globalisation, outsourcing and Just-In-Time principles, in combination with the increasingly active role of inland terminals. Inland terminals can fulfil a shippers' desire to become more environment-friendly through introducing the use of multi-modal transport including inland waterways. Besides multi-modal transport, the use of an inland terminal within the overall supply chain offers cost-saving opportunities. On the other hand, it also introduces a number of risks to the overall supply chain, as planning of inland waterways transport involves dealing with a number of uncertainties arising from the complex logistics of the deep sea ports.

From the perspective of SEC, this project focuses on the social characteristics of an inter-organizational collaboration that is formed between the inland terminal operator and the shipper or customer. Supply chains are generally made up of multiple supply chain partners e.g. first and second tier suppliers, resulting in supply chain partnerships. These partnerships consist of organizations which can be part of the same mother company, or can also consist of different organizations, and thus forming an inter-organizational partnership. Inter-organizational collaboration introduces certain barriers to information sharing and partnership performances, adding an extra challenge to the overall process. These challenges can take the form of certain social aspects, such as cultural differences, and relationship specific assets, including an undermining of trust and commitment, and may therefore hinder a quick and efficient decision-making process within the inter-organizational collaboration. Which is alarming, considering that in the field of SCRM quick and efficient decision making is deemed very important as it can limit the impact of disruption on the supply chain processes. This underlines the value of understanding the involved social characteristics and their effect on communication within an inter-organizational partnership.

The integration of both fields creates an added value to both perspectives as it combines the social factors of inter-organizational collaboration and the role of efficient communication and decision-making, within the SCRM and SC-disruption management of an inland terminal.

As the project is fully integrated, the report is not divided into a SEC- and TIL-part. Identifying and evaluating the supply chain risks and evaluating the current mitigation treatments and supply chain disruption management can be predominantly linked to TIL. The identification of information sharing barriers and partnership performance indicators are mainly related to SEC. However both are not exclusive, as they are interdependent. The evaluation of the current monitoring processes is equally linked to both fields. From a TIL-perspective, an evaluation is made of the monitoring of risks and the current disruption management: specifically whether the right risks are being monitored, and whether all risks are being monitored and if the impact of disruptions are being limited through an efficient decision making process. From a SEC-perspective we focus on the communicative design behind the monitoring and detection methods.

Finally, a tool is created that takes into account both the partnership performance indicators, information sharing barriers and identified traditional SEC-risks, and focuses on a more efficient and quick recovery from disruptions. To understand the added value of this tool, the overall report or summary should be read.

Chapter 1 introduces the topic, motivation and questions of this research. This chapter is therefore important to read for a complete understanding from both fields. Chapter 2 describes the theoretical foundation of this research. Section 2-2 mainly focusses on the inter-organizational challenges from a SEC-perspective. Section 2-1-2 and 2-1-1 focus more on the theory behind SCRM and SC-disruption management from a TIL-perspective. Section 2-3 focusses on a theory from project management and a theory on goal setting and motivation and can be read from both perspectives. Chapter 3 discusses the research framework and the structure of the report and is therefore applicable to both perspectives, and is recommended to be read in order to understand the chosen structure and methodology of the research. The same accounts for Chapter 4. This chapter includes information on the case study as the subject of this research, and this information is required for both perspectives. Chapter 5 is subdivided into sections, from which some are more related to one of the two perspectives. Section 5-1, Section 5-2 focus on supply chain risks and disruptions from a predominantly TIL-perspective. Section 5-3 focusses more on the social factors that play a role in the collaboration between HNS and Alpherium and can therefore be linked to SEC. The following chapters combine both fields overall, and contribute to the final conclusion in which the perspectives are brought together. However, Section 8-1 and Appendices A, I, E, G and F have a strong connection to the field of TIL, as they discuss the theory behind supply risks, and risk mitigating actions without a focus on collaboration. Appendix 4-2, on the other hand, focusses more on the more social aspect of this research.

Overall I would recommend to read the summary and conclusions or the report in total in order to fully understand the steps, analyses and outcomes of this research.

Summary

Over the years supply chains have evolved under the influence of the development of supply chain management trends and as a result became more complex. While all these trends can lead to competitive advantages, they also create supply chains which are more vulnerable to risks and disruption impacts. Making Supply Chain Risk Management (SCRM), as well as dealing with SC(Supply Chain)-disruptions, are some of today's greatest business challenges for supply chain management.

Seaports and inland terminals have been fulfilling an increasingly active role within supply chains. Shippers nowadays often seek "efficient and sustainable multi-modal transport services" (Veenstra, Zuidwijk, & van Asperen, 2012), as the growth of freight transport leads to growing concerns about congestion, harmful emissions and safety issues. These developments have led to an increasingly important role for the inland terminals in world-wide supply chains. With the expectation of further terminalisation of supply chains, it is assumed that SCRM and dealing with SC-disruptions from an inland terminal's perspective will be of an increased importance over the coming years.

An example of a collaboration between shipper and inland terminal where the shipper aims to use multi-modal transport is the collaboration between Heineken Nederland Supply (HNS) and the inland terminal Alpherium. Alpherium functions as a logistic service provider for HNS. They manage a part of the transport and planning for the brewery in Zoeterwoude. Transport of containers to and from the brewery by truck, and transport by barge from and to the deep sea terminals in Antwerp and Rotterdam. The terminal is used for the storage and transshipment of empty and loaded containers. Because there is a limited product import flow to Alpherium, the overall process heavily depends on the import of empty containers. By regulating the supply of empty containers to the brewery in Zoeterwoude, Alpherium functions as a cross-docking facilitator for the brewery in Zoeterwoude. The brewery in Zoeterwoude has very limited storage capacity and targets on cross-docking all overseas export production. The empty container availability (CA) therefore plays a crucial role in this collaboration. The barge planning influences the supply of empty containers and is therefore directly linked to the CA. HNS creates a loading plan, stating when products are expected to be loaded and in which containers. The CA is determined by the compatibility of the barge planning and the loading plan.

The definition used for supply chain risk in this research is as follows: "supply chain risk is the potential loss for a supply chain in terms of its target values of efficiency and effectiveness

evoked by uncertain developments of supply chain characteristics whose changes were caused by the occurrence of triggering events" (Heckmann, Comes, & Nickel, 2015). A supply chain disruption is defined as "an event that takes place at one point in the chain and can adversely affect the performance of one or more elements located elsewhere in the supply chain and the normal flow of goods and materials within a supply chain"(Behdani, 2013). Risk and disruption management can be combined according to an integrated framework. This framework consists of a risk management cycle that is focused on "discovering potential disruptions and prevent them from becoming actual disruptions", and a disruption management cycle aimed at "handling the actual disruption once it has occurred and to use that experience to learn so as to avoid, reduce or transfer the risk of happening similar potential disruptions in the future"(Behdani, 2013). This framework is combined with the case study in order to answer the sub-questions stated below.

The main research question related to the aim of this research is:

- *How can supply chain risks and disruptions with a focus on empty container availability be managed as part of the inter-organizational collaboration between an inland terminal and shipper taking into account the collaborative challenges?*

In order to answer the main research question we need to answer a number of sub-questions.

1. What are the possible supply chain risks to empty container availability at an inland terminal considering both information and material flows, and what are the related risk levels?
2. What are possible mitigating actions that could address the identified supply chain risks?
3. How can supply chain disruptions at an inland terminal with a focus on empty container availability be managed in order to limit the disruption impact?
4. What are possible challenges from an inter-organizational perspective that could limit the partnership performances and information exchange between inland terminal and shipper?
5. How can supply chain risk and disruption management be implemented in order to address these inter-organizational challenges?

Case study results

[1] The highest risk likelihood can be paired to operational risks such as supply uncertainties, barge planning under high uncertainty, and forecast inaccuracies, all resulting in the unavailability of empty containers. These are considered as external operational risks, and can therefore not be internally fixed. The main cause of supply uncertainties, which also leads to planning uncertainties, is the way that barge rotations at the deep sea terminal are carried out. Due to the lack of central regulation and the relatively low priority of barge transport, the planned barge rotations suffer from the whimsicalities of the terminal operators and a

limited time horizon. The forecast inaccuracies relate to the moment of loading, which is dependent on events within the brewery.

[2] Taking into consideration the fact that the highest risk levels can be directly linked to the uncertainty of the empty container supply and to forecast inaccuracies concerning the loading moments at the brewery, the main mitigating actions at the case study are a safety stock combined with a safety lead time. The safety lead time is determined to be three days. This means that the container should be available three days for the expected loading moment (CA t-3). The planning processes and lead times of the containers create barriers that make it impossible to manage this safety lead time. Therefore, the safety stock is determined in such a way, that the safety lead time can be managed. The safety stock as determined at Alpherium serves two goals. It ensures the maintenance of the safety lead time and it can absorb (part of) the impact of a disruption to the supply of empty containers.

Another mitigating action that deals with one of the operational risks with a high likelihood is sailing with extra transport capacity in the form of redundant barge capacity. Due to uncertainty and short term view caused by the dynamics of the deep sea terminals in Rotterdam and Antwerp, the barge planning is highly uncertain. To deal with this the barge planner poses a flexible and resilient barge planning, that carries redundant barge capacity in case delays or capacity constraints arise as a result of limited deep sea terminal handling capacities.

[3] To manage supply chain disruptions, it is of great importance that the monitoring process as part of the risk mitigation actions is able to detect a situation where a risk results in an actual disruptive event. At Alpherium they do this trough focussing on the CA, per different container type and colour (of which shipping line). Joint-management helps to detect disruptions early on and provides enough time to react and limit or prevent a disruption impact. Another way of limiting the impact of a disruption is through having a pre-defined plan when mitigating actions are not enough to prevent a disruption from impacting the critical objective. Alpherium and HNS set up a contingency plan.

[4] Overall, the well structured information exchange, long term orientation and shared vision and goals seem to support the partnership performances as a result of the inter-organizational collaboration between HNS and Alpherium. However there were a number of characteristics that seemed to form a challenge. The level of credibility trust, “trust in the ability of Alpherium to meet their obligations” was interpreted as low (Cullen, Johnson, & Sakano, 2000). This was caused by a lack of insight of HNS in recovery decisions made by Alpherium and Alpherium’s lack of timely information exchange in case of a disruption. The low level of credibility trust could decrease the perceived satisfaction and through that further decrease overall trust from HNS in Alpherium.

By analysing the case study, some gaps in the current supply chain risk and disruption management practices were uncovered. The identified gaps were:

- CA t-3 recovery

Recovery of the safety stock after a disruption currently takes longer than desired. If the safety stock is not fully replenished, the CA t-3 is not attainable. It was found that during or after a disruption, detection and reaction took place on a detailed level, where the impact was determined per container type and colour. Recovery was then focussed on the actual loading moment, as this has the highest priority. As a result the impact on the state of the safety stock would not be taken into account when deciding on recovery actions.

- Lack of detection and the current method of barge planning

The redundant barge capacity is part of the way the barge planning is carried out. In general the barge planner can lose about two import trips, before the CA drops to low. However, a number of smaller disruptions could jointly exceed the two trips. Because smaller disruptions were not registered, there was no way of detecting this before it would have an impact.

- Safety stock

The way of determining the safety stock at Alpherium does not take into account fluctuations in demand. Since demand is not consistent, this could lead to surpluses or shortages of the safety stock. However, demand deviations could not be determined. Demand was based upon the tender, including the annual allocation between the shipping lines which is renewed each year. Therefore there is no available historic data to determine the standard demand deviation.

- Contingency plan

The current contingency plan was incomplete, vague and had no clear aim. This resulted in friction afterwards, as the aim was differently interpreted by the two organizations, possibly causing a decrease of trust between partners.

Recommendations to the case study

A tool was developed, combining detection of smaller disruptions, supporting the estimation of a disruption impact on a higher level with a model and providing information to support decision making. The disruption impact model offers a calculation that offers an estimation of the impact of a disruption on the transport capacity. This way, all lost capacity (apart from the redundant capacity) is the focus of recovering actions. The model uses the barge planning as a starting point, and estimates the impact based on a reduction in possible sailing hours or barge capacity over the week. The decision support offers an insight into expected recovery durations per recovering action and a rough estimation of the costs.

Small adaptations to the contingency plan, by adding sources of information and formulating a new aim should improve the current version and prevent collaborative friction. The disruption impact tool can be used as part of the new contingency plan, in order to inform all those involved about impact, causes and expected duration of recovery. By taking into account high- and low season demand per country of customers, the safety stock could incorporate a high and low season.

[5] It was found that there were a number of issues that should be carefully considered when implementing SCRM and SC-disruption management as a collaborative effort within

a inter-organizational collaboration. It is very important that adaptations govern a well thought-out and defined structure to offer a frequent and high quality information exchange that can support a quick decision making process as well as the growth of trust and perceived satisfaction.

Improving current SCRM and SC-disruption management does not directly address the inter-organizational challenges. However, better results in general can improve the relation between the organizations. Behavioural uncertainty, as well as supplier uncertainty could be decreased through partnership performance improvements.

Conclusions

All of the above was determined by means of the case study analysis. The structure of the case study is not very common for inland terminals. Because of the high volumes of Heineken, they have the opportunity to 'force' the shipping lines to use the infrastructure of Alpherium and have Alpherium serve as an extended storage gate to the shipper. Other characteristics as the critical objective, the limited storage capacity at the warehouse of HNS, the import-export balance and the goal of barging all export production strongly influence the design of SCRM and SC-disruption management. However this research still offers a valuable conclusion to inland terminals in general.

The final conclusion provides a general insight into the types of risk inland shippers deal with, and how SCRM and SC-disruption management should be a joint effort, with a well-structured information exchange support. Inland terminals and shippers can use these outcomes as a general directive when implementing or adapting their SCRM and SC-disruption management. This research also underlines the importance of taking into account relational characteristics and social factors and offers the main topics for consideration when doing so.

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Glossary

List of Acronyms

CA	container availability
CSE	customer service and export
HNS	Heineken Nederland Supply
OS	operational scheduling department
OTA	inland terminal Alpherium
SC	supply chain
SCM	supply chain management
SCRM	Supply Chain Risk Management
SEC	Science Communication
TEU	twenty feet equivalent unit
TIL	Transport, Infrastructure & Logistics
TMA	theoretical maximum supply capacity
TOC	theory of constraints

Part I

Research

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Chapter 1

Introduction

1-1 Motivation

The basics of supply chain management assume a supply chain following processes from supplier(s) to end-customer(s) (Croxton, García-Dastugue, Lambert, & Rogers, 2001). One example of the many definitions is, "a supply chain consists of two or more legally separated organizations, being linked by material, information and financial flows. These organizations may be firms producing parts, components and end-products, logistic service providers and even the (ultimate) customer himself" (Stadtler, 2000). Increasing the organization's competitiveness is one of the goals of managing a supply chain. This can be done through a better coordination of material, finance and information flows (Stadtler, 2000; C. S. Tang, 2006). These days, instead of competing companies, we speak of competing supply chains. None of the single organizations or organizational entities as part of a supply chain are directly responsible for the overall product or service as received by the customer, making supply chain management a crucial part of increasing competitiveness (Stadtler, 2000; Zsidisin & Ritchie, 2008).

Over the years supply chains have evolved under the influence of the development of supply chain management trends, and so became more complex. In the last two decades, four key trends were identified (Behdani, 2013). The *Just-In-Time principle*, *Outsourcing*, *Global Sourcing* and *Supply-base Reduction*.

1. The Just-In-Time principle stands for removing waste from the supply chain, reduced inventories and more efficient production processes. In order to remove waste, the JIT-principle focuses on making products and materials available only when needed (Behdani, 2013).

2. Firms are increasingly outsourcing (Meixell & Gargeya, 2005). Firms are shifting their non-core activities to third parties who manage these activities on behalf of the firm. There can be several reasons for a firm to outsource their activities, e.g. financial or technology reasons (Rushton, Croucher, & Baker, 2014).

3. Another trend that has emerged is global sourcing. This means that companies combine domestic and international sourcing in order to increase their competitive advantage. Mostly global sourcing is done in order to save costs and access cheaper resources (Behdani, 2013).

4. The fourth trend as discussed by Behdani (2013), is supply-base reduction. Supply-base reduction is simply reducing the number of suppliers that the organization uses. A reason for this trend is to improve buyer-supplier relationships as well as removing waste in the form of administration and transaction costs.

While all these trends can lead to competitive advantages, they also create supply chains more vulnerable to risks (Behdani, 2013; Spekman & Davis, 2004). According to Behdani (2013) this is mostly due to the supply chain management (SCM)-trends global sourcing and outsourcing. He states that disasters no longer have just a local effect, as they impact overseas manufacturers or other suppliers and therefore have a higher risk of negatively affecting multiple supply chains' performances. Outsourcing can lead to risks related to the supply chain partner and possible conflict of views. The trends Just-In-Time and supply-base reduction lead to higher risks concerning resource availability. Limited stock and high dependency of one supplier could result in a quickly spreading impact of a disruption. And to add insult to injury, due to the high complexity of today's supply chains, the decision-making process that deals with disruptions lacks speed (Sheffi & Rice Jr, 2005).

Supply Chain disruptions (SC-disruptions) can take on many different forms, from a transport delay or poor communication to a natural disaster or a terrorist attack (J. Blackhurst, Craighead, Elkins, & Handfield, 2005). They can affect the supply chain performance through e.g. increasing costs, failing to meet customer's demand and stock-outs. An example of a disastrous disruption effect is a labour strike that took place in 1996 at General Motors. It eventually led to a "reduction in quarterly earnings of $900 million" (J. Blackhurst et al., 2005). Another famous example is case of Ericsson and Philips, where a fire at Philips caused a production shut down for Ericsson, resulting in €400 million damage (Sheffi & Rice Jr, 2005).

In conclusion due to recent trends in supply chain management, not only have supply chains become more vulnerable to possible disruptions in the form of supply chain risks, these disruptions are likely to have an increased negative impact. Making Supply Chain Risk Management (SCRM), as well as dealing with SC-disruptions one of today's greatest business challenges (J. Blackhurst et al., 2005; H. Christopher & Peck, 2004).

According to Rodrigue and Notteboom (2009) supply chains are subject to an increasing *terminalisation*, meaning that seaports and inland terminals have been fulfilling an increasingly active role within supply chains. Van den Berg and De Langen (2015) state that "international container transport is the backbone of global supply chains". Shipping lines offer transport of containers port-to-port and door-to-door. When offering door-to-door transport, shipping lines often outsource their inland transport, which is called merchant haulage. Shipping line haulage defines "inland transport controlled by the shipping lines" (Van den Berg & De Langen, 2015). Besides port-to-port and door-to-door propositions, Van den Berg and De Langen (2015) speak of a port-to-inland terminal proposition. A port-to-inland proposition means that transport to the inland is provided but not to the end-destination. Advantages of the port-to-inland terminal system include the following: it can enable triangulation of containers, "reusing empty import containers for export bookings" (Loo, 2012), it does not require a tight integration between shipping line and shipper; it offers inter-modal transport possibilities to the shipper (Van den Berg & De Langen, 2015).

Shippers nowadays often seek "efficient and sustainable multi-modal transport services" (Veenstra et al., 2012), as the growth of freight transport leads to growing concerns about congestion, harmful emissions and safety issues (Konings, 2007). These developments have led to an increasingly important role for the inland terminals in world-wide supply chains. As a result, the inland terminals will have to deal with the challenges that port communities are facing, e.g. congestions and delays. Their task is to mitigate the impact of these challenges on their operations as well as focusing on, for instance, managing their information capabilities and customer relationships (Veenstra et al., 2012). With the expectation of further terminalisation of supply chains (Rodrigue & Notteboom, 2009), it is assumed that SCRM and dealing with SC-disruptions from an inland terminal's perspective will be of an increased importance over the coming years.

An example of a port-to-inland terminal proposition where the shipper aims to use multi-modal transport is the collaboration between Heineken Nederland Supply (HNS) and the inland terminal Alpherium. This partnership serves as the case study used in this paper to discuss SCRM and dealing with SC-disruptions from an inland terminal's perspective in collaboration with HNS as the shipper. The case study will be described in detail in Chapter 4.

1-2 Research problem

As described above, trends in supply chain management have created supply chains that are more vulnerable to disruptions, resulting in an increasingly important role for risk and disruption management. Without this, the vulnerability of a supply chain could lead to higher impact of disruptions resulting in high costs and the inability to meet customer demand. With the current terminalisation of supply chains (Rodrigue, 2016), disruptions at inland terminals could have a broad impact on numerous global supply chains. Therefore both preventing and managing supply chain disruptions from an inland terminals' perspective deserve a prominent role in the field of SCRM and SC-disruption management.

The previous section discussed the port-to-inland terminal structure. An example of a port-to-inland terminal construction is where the inland terminal fulfils the role of a load centre. This means that the storage capacity at the inland terminal functions as "an extended storage area" of the shipper or customer (Van den Berg & De Langen, 2015). The inland terminal and shipper are usually located close together, so that an order for a container can be met in a short amount of time. This structure requires intensive collaboration between the inland terminal and the shipper (Van den Berg & De Langen, 2015). A possible definition of this practice is a "warehousing-derived" function of an inland terminal (Rodrigue & Notteboom, 2009). Such a structure leads to a main buffer function for the inland terminal. And although it seems to contradict the Just-In-Time trend discussed earlier, it offers the shipper the possibility of lowering warehouse costs and the chance to deal with both variable demands and/or delays (Rodrigue & Notteboom, 2009). From the perspective of an inland terminal, the performance of this buffer stock is an important condition for securing the continuity of the supply chain processes. Major shippers can use inland terminals as empty container depots, realizing the opportunity to deliver containers on a short time notice (Van den Berg & De Langen, 2015; Rodrigue & Notteboom, 2009). To function optimally as an empty depot for the shipper, the inland terminal must focus on the availability of empty containers, in order to deliver requested containers to the shipper in time. The collaboration between HNS and the inland terminal Alpherium is an example of such a port-to-inland terminal structure.

When it comes to dealing with a risky situation or a disruption, the nature of the intensive collaboration e.g. between shipper and inland terminal, becomes extremely important. Such situations are characterized by “a high degree of uncertainty and lack of accurate information” (Chen, Xia, & Wang, 2010). In order to decide on well-coordinated and effective actions, accurate information is required as soon as possible, so information sharing between the two organisations is crucial (Hatala & Lutta, 2009). However, information sharing between supply chain partners can be subject to barriers due to organizational differences between partners. According to S. Li and Lin (2006), the extent to which inter-organizational partnerships are based on trust, commitment and shared vision influences both the level and the quality of information shared. Another critical factor in sharing information is organizational culture. Organizations with a similar culture tend to interact more easily, leading to better performances because common interpretations and routines ease the collaboration (Knoben & Oerlemans, 2006). A lack of these similar characteristics in a supply chain partnership can act as a barrier to information sharing, and therefore harm the effectiveness of collaborative planning and decision-making (Petersen, Ragatz, & Monczka, 2005; Waters, 2011).

In conclusion, the inter-organizational collaboration between shipper and inland-terminal brings an additional challenge to dealing with risks and disruptions. Information sharing barriers could slow down and decrease the efficiency of the decision-making process. However, for the process of risk and disruption management, quick and efficient decision-making is very important in order to detect risks or disruptions as well as a quick way to recovery (Behdani, 2013).

1-3 Research goal and questions

The overall project focuses on the SCRM and SC-disruption management as part of the collaboration between inland terminal and shipper. The collaboration between inland terminal Alpherium and HNS is used as a case study for this project.

Risks exist in many different forms and can take place in different flows within the supply chain. Supply chain literature speaks of three different supply chain flows; goods, information and money. All three flow through a supply chain between supply chain partners, supplier, manufacturer and the end customer. Supply chain partners collaborate and combine their activities in order to achieve optimal supply chain performances. Improving and increasing the sharing of information among partners can help optimise partnership efficiency and supply chain performances through improved decision making (Hatala & Lutta, 2009; Spekman & Davis, 2004; C. S. Tang, 2006).

This research aims to identify and evaluate supply chain risks, possible mitigating actions and practices for SC-disruption management as part of a supply chain partnership between shipper and inland terminal. It also aims to find a way to better manage these risks and disruptions as part of the partnership performance, by taking into account the social factors of an inter-organizational collaboration.

The scope of this research focuses on the use of an inland terminal as an empty depot or in a warehousing-derived function for the shipper as described earlier.

A case study of a collaboration between HNS and the inland terminal Alpherium is used as a research strategy. The motivation for this research originated from the question posed by HNS and Alpherium to re-evaluate their current risk and disruption management and identify and address current gaps.

The main research question related to the aim of this research is:

- *How can supply chain risks and disruptions with a focus on empty container availability be managed as part of the inter-organizational collaboration between an inland terminal and shipper taking into account the collaborative challenges?*

In order to answer the main research question we need to answer a number of sub-questions.

1. What are the possible supply chain risks to empty container availability at an inland terminal considering both information and material flows, and what are the related risk levels?
2. What are possible mitigating actions that could address the identified supply chain risks?
3. How can supply chain disruptions at an inland terminal with a focus on empty container availability be managed in order to limit the disruption impact?
4. What are possible challenges from an inter-organizational perspective that could limit the partnership performances and information exchange between inland terminal and shipper?
5. How can supply chain risk and disruption management be implemented in order to address these inter-organizational challenges?

Risk levels present the combination of a risk's likelihood and impact. This will be discussed in more detail in Chapter 3. Mitigating actions are "actions to reduce the likely adverse effects" of a disruption (Walker, Haasnoot, & Kwakkel, 2013). Inter-organizational collaboration is a collaboration between two organizations, belonging to a different (mother) companies.

In order to answer the questions posed above, the case study is used as an example of a collaboration between inland terminal and shipper. Based on the case study we identify the possible supply chain risks, disruptions and possible effects. This should make clear in what type of situations decisions should be made and which information should be shared between the two organizations. By understanding what the barriers to information sharing between the organizations are, this knowledge can be used to overcome these barriers and support the decision making process in order to improve the supply chain risk and disruption management of the case study. By analysing the SCRM and SC-disruption at the case study, certain gaps might arise that should be addressed. Subsequently, the answers to the sub questions are reviewed and compared to literature to determine the applicability of the answers to a collaboration between inland terminal and shipper in general.

1-3-1 Structure of the report

This report is subdivided into three parts. The first part consists of the actual research. Chapter 1 introduces the motivation for this study, the related research problem, goal and questions. After introducing the case study in the next section, Chapter 2 discusses the theoretical framework used as the foundation for this research. Chapter 3 discusses the research framework and methodologies used for answering the several sub questions and main research question. Subsequently, Chapter 4 provides a detailed insight into the case study, its stakeholders and the overall processes. After discussing the case study in detail, it functions as the input for Chapter 5. This chapter discusses the current SCRM and SC-disruption management practices at the case study based upon the research framework discussed in Chapter 3 and keeping in mind the theoretical foundation of Chapter 2. It also discusses the collaborative characteristics of the partnership between HNS and Alpherium, and if these form any challenges to the overall performances, based upon the theoretical foundation associated with inter-organizational collaboration. Thereafter, Chapter 6 defines, based upon the outcome of the analysis performed in Chapter 5 the gaps that need to be addressed in order to improve the current SCRM and SC-disruption practices of the case study. These defined gaps will result in requirements that function as the input for part II of this report.

Part II starts of with a chapter on the development of a decision support tool containing a disruption impact model in order to address the gaps defined in Chapter 6. Chapter 8 describes a number of smaller adaptations that could help improve the SCRM performances of the case study. Part II is the non-empirical part of this research, as it is based upon the personal ideas and insights of the researcher. The tool will provide an example of possible SCRM and SC-disruption support based upon the gaps found at the case study, but gives no scientifically founded outcomes.

The third and final part of this report starts of with Chapter 9, discussing the results and reflecting on the data, research framework and methodology used to answer the research questions. Considering the aim of this research, the discussion is placed before the conclusion. This is done because the case study shows a specific structure of collaboration between shipper and inland terminal. This structure can influence the outcome of the research questions in such a way, that it might not match the theoretical foundation or be applicable to other structures. By discussing the results, we aim to discover the degree this structure has influenced the outcomes. The same accounts for the influence of the chosen framework and the data associated with the case study. This way the conclusion in Chapter 10 can address both the case study as well as the outcomes of the discussion. Finally the report provides a number of recommendations, again related to the case study and for inland terminals in general. These recommendations, together with some recommendations for further research can be found in Chapter 10.

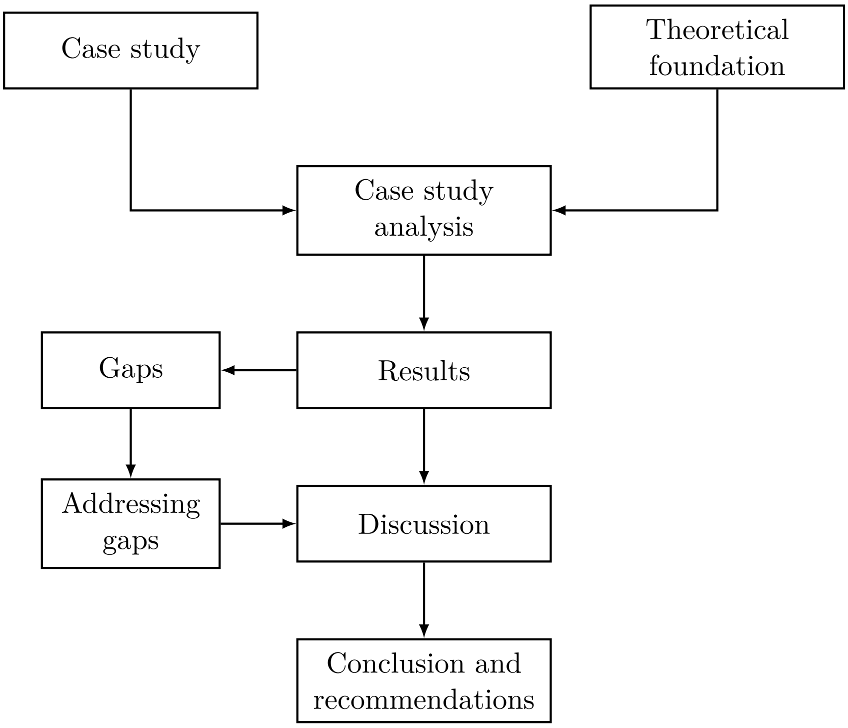

Figure 1-1: Research structure

1-4 Case study introduction

This section provides a short introduction of the case study. The case study will be analysed in detail in Chapter 4.

This graduation project presents a case study about a supply chain partnership between an inland terminal in Alphen aan den Rijn and HNS. HNS is part of Heineken Nederland BV, a large international beer brewer with a global customer network. In 2014 Heineken produced over 180 million hectolitres globally and served customers in more than 170 countries. Currently Heineken owns three breweries in the Netherlands: Two Heineken breweries at Zoeterwoude and Den Bosch, and one Brand Brewery in Wijlre.

HNS functions as a production subsidiary of Heineken Nederland BV., for inland and export products, and manages the supply chain for the three breweries in the Netherlands. Over 70 percent of HNS' production is exported, which requires a lot of logistical planning. At the planning department, the production within the breweries is planned broadly on a strategic level, and is planned in detail on a tactical level. The operational departments ensure that everything is ready in order to execute the planning (HNS, 2015). With the production of millions of hectolitres and global distribution, HNS manages their activities within a complex and extensive supply chain (International, 2014).

As stated earlier HNS exports over 70 percent of its production. Part of the production for export is transported over water (HNS, 2012). The deep sea terminals in Rotterdam and Antwerp function as the gateways to the international clients e.g. in New York. In the past, loaded containers were transported by truck to the deep sea terminals. In 2010, as an initiative from Van Uden, a logistics service provider, and HNS, the inland terminal Alpherium was opened in Alphen aan de Rijn. The terminal functions as a transfer terminal in order to support multi-modal transport for the export beer of Heineken, produced at the brewery in Zoeterwoude. Alpherium has a storage capacity around 60.000 m^2 and a handling capacity of approximately 200.000 twenty feet equivalent unit (TEU) a year (Van Uden, 2015). Besides Heineken, Alpherium collaborates e.g. with Zeeman, a Dutch textile retailer, and Intertoys a Dutch toy, game and multimedia retailer. Heineken is by far their largest client. Over 90% of all container handlings at Alpherium are made by order of HNS. As organizations, Alpherium and HNS remain completely separate and are therefore part of two different organizations, necessitating an inter-organizational collaboration.

At the start of the collaboration, Alpherium, together with HNS, formulated four general goals to be attained through the collaboration between the brewery and the inland terminal. The goals as defined by HNS and Alpherium are:

1. *Reliability of supply:* Introducing a new modality (inland waterway transport) might better secure the supply and discharge of containers to the terminals in Rotterdam and Antwerp (Less dependent on road traffic).

2. *Reduction of transport costs:* In the medium term, this added modality will hopefully result in an advantage in total transport costs (road pricing, oil prices).

3. *Reduction of harmful emissions:* The introduction of Alpherium could lead to a decrease around 8 million kilometres road transport, per year, since a significant number of trucks are being replaced by barges.

4. *Improved process optimization:* An improved container availability could result in an increased cross-docking percentage by offering available containers at the requested times, and so improving a continuous production flow (HNS & Alpherium, 2012).

Figure 1-2 shows a simplification of the export flow of loaded containers as well as the import flow of empty containers. To provide more detailed insight into the processes, with respect to both material and information flows, a Value Stream Map is constructed in Sectio 3-2-1. The scope of this research focuses on the import flow between the deep sea terminals and the inland terminal.

Because there is a limited product import flow to Alpherium, the overall process heavily depends on the import of empty containers. Through regulating the supply of empty containers to the brewery in Zoeterwoude and providing storage capacity for the loaded containers, Alpherium functions as a cross-docking facilitator for the brewery in Zoeterwoude. The brewery in Zoeterwoude has a very limited storage capacity and targets on cross-docking all overseas export production. Cross-docking is "the transfer of goods and materials from an inbound carrier to an outbound carrier, without goods or products actually entering the warehouse or being put away into storage" (Kulwiec, 2004). The empty container availability therefore plays a crucial role in this collaboration.

1-4-1 Container availability

If production is packed and palletized at the brewery, it will be loaded into an assigned empty container. If the assigned container is not available at the moment of calling an

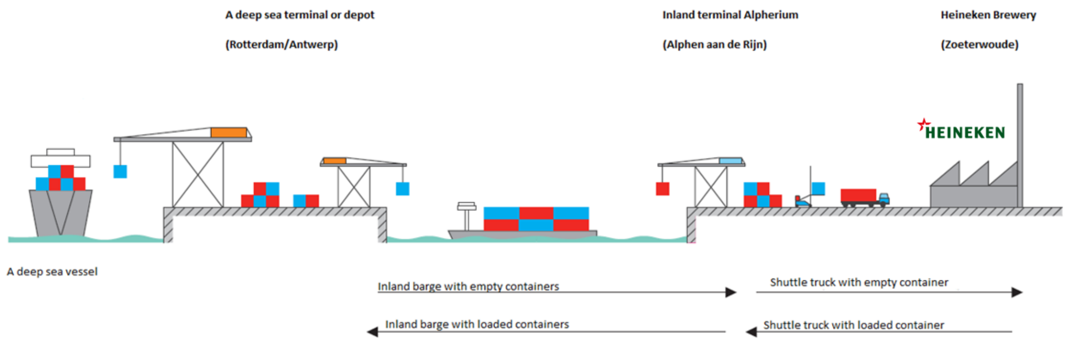

Figure 1-2: Simplified scheme of transport process

empty container, production cannot be loaded and therefore has to be stored in the export warehouse of the brewery, leading to a decrease in the limited storage capacity and an increase in handlings. In order to prevent export production from going in to stock, the planning department at Alpherium looks to adapt their barge planning on the production and loading planning created at Zoeterwoude. This way they can forecast the container availability (CA) and act upon it.

Figure 1-3 shows the CA schematically as part of the supply chain transport process. The inland terminal Alpherium functions as a location where both empty and loaded containers can be kept in stock for a certain period. The empty container stock decreases the moment an empty container is requested and transported to the brewery in Zoeterwoude. There, as stated earlier, the empty container is loaded with HNS's products and returned to Alpherium where it enters the loaded container stock. In principle the transport of containers from and to the deep sea ports is done by barges, however if necessary trucks can be used for transport as well.

Each loaded container is linked to a specific journey, planned to leave from an assigned deep sea terminal with an assigned vessel on a pre-specified day and time, named closing time. The loaded containers leave the loaded container stock and are transported to the deep sea terminals by barge. On their way back to Alpherium, the barges bring back empty import containers to replenish the empty container stock.

As can be seen in Figure 1-3, the process basically consists of four transport flows. Flow 1 replenishes the empty container stock, flow 2 depletes the empty container stock, flow 3 adds to the loaded container stock and flow 4 results in a decrease of the loaded container stock. It can be seen that with the elimination of one of the four flows, e.g. as the result of a disruption, the container stocks will either be completely depleted or will keep increasing due to the loss of an export flow, which would lead to problems with respect to the restricted storage capacity at Alpherium. The increase of one stock (loaded or empty) results in less capacity for the other.

If as a result of a disruption, (part of) the supply of empty containers would become impossible, cross-docking of production into those empty containers becomes impossible. With limited storage space at the brewery, storage will also soon become impossible, and the whole

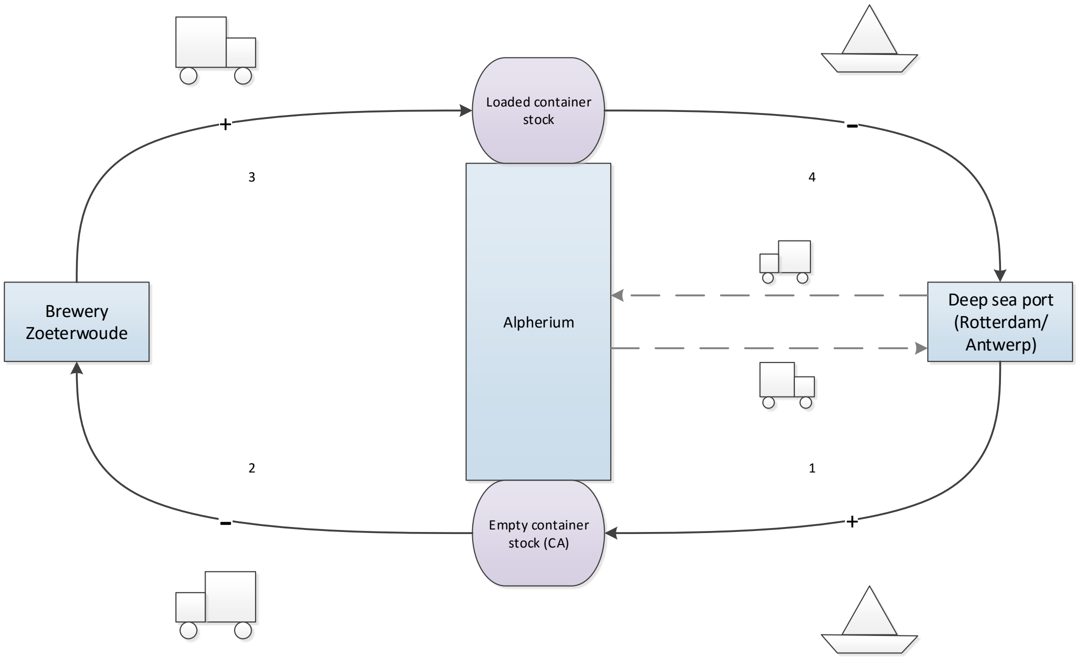

Figure 1-3: Container Availability and different transport flows

process would stagnate, including production at the brewery. This would be a very costly outcome and should be prevented at all times. Therefore the CA is considered a Key Performance Indicator (KPI) as part of the supply chain performances. A Key Performance Indicator is "the measure of a process that is critical to the success of an organisation" (Swan & Kyng, 2004).

Logically the empty container stock is directly linked to the CA. The empty container that is requested and transported to the brewery is part of the empty container stock. However, having a high empty container stock does not necessarily translate into a high CA. HNS collaborates with a number of different shipping lines, for different destinations. Resulting in different container "colours".

These container colours bring an added complication to the process. As described earlier, every loaded container is assigned to a specific journey and vessel. This journey is facilitated by one of the many shipping lines that have a contract with HNS. The chosen shipping line depends on the destination of the journey and that year's allocated volumes per shipping line. Whichever shipping line is chosen, determines the "colour" of the container in which the product is loaded. This means that when production is loaded into a container, the container colour should match the shipping line of its journey to the end customer. So in this specific context the colour indicates to which shipping line the container belongs. The reason for choosing multiple suppliers consists of a financial incentive as well as the destinations of different shipping lines, their trip times and the number of transits.

Besides colour, production is also assigned to a specific type of container. Type could refer to size, and reefer (refrigerated container), non-working reefer or a standard container. Therefore, when replenishing the empty container stock, it is not just the number of containers but also the type and colour that should be taken into account. Table 1-1 provides an arbitrary example of different container colours. Each row represents a different container colour and type.

Table 1-1: Container types and colours

Shipping line	Type
MSC	40DR
Samskip	45 PW
APL	20DR
Hapag Lloyd	40RF

The scope of this research focuses on the CA, and therefore mainly on the import flow of empty containers from the deep sea terminals and depots to Alpherium. However, the import and export flow are inextricably linked and the export flow can therefore not be totally extracted from the scope of research. Throughout this research the shuttle service between the brewery and Alpherium is assumed as immune to issues. Containers available at Alpherium are considered available to the brewery. Dealing with issues of the shuttle service can be subject to an entire research on its own, and was therefore not included within this research.

Chapter 2

Theoretical framework

2-1 Supply Chain Risk Management

Literature on supply chain risk management (SCRM) is very extensive. Research about SCRM is done from diverse perspectives and approached from different domains (Sodhi, Son, & Tang, 2012). However most researchers agree that due to recent trends in SCM such as globalization, outsourcing, cost reductions and agile logistics, supply chains are becoming more vulnerable. Vulnerability in this context "reflects the susceptibility of a supply chain to disruption" (Waters, 2011). Because of the increased vulnerability in supply chains, creating a resilient supply chain through supply chain risk management becomes more and more important. Resilience is defined as: "the ability of a system to return to its original state or move to a new, more desirable state after being disturbed". The robustness of a supply chain emphasizes the "ability to cope with errors" (H. Christopher & Peck, 2004), or as a system's "ability to withstand or survive external shocks; to be stable" (Bankes, 2010). Both are deemed important when dealing with risks and disruptions.

2-1-1 Supply chain risks

Before we determine the definition of supply chain risk management, we need to define risk in general. The Oxford Dictionary gives as one of many definitions "a situation involving exposure to danger". Waters (2011) describes risk as a result of uncertainty about future events. According to Manners-Bell (2014), risk is the probability multiplied by the severity or impact of a given event. This corresponds with the definition of risk as given by March and Shapira (1987), who defined it as "the product of the probability of occurrence of a (negative) event and the resulting amount of damage". So in contrast to uncertainty, risk suggests a probability of an event happening in the future, whereas uncertainty says nothing about the likelihood of an event (Waters, 2011). Manners-Bell (2014) gives three different categories for risks.

1. "Known and prepared for (Events have occurred in the past and should be prepared for in the future (although and time, place and severity unknown) ;

2. Known and unprepared for (Events have occurred in the past but corporations/governments have failed to prepare);

3. Unknown unknowns (impossible to predict but could do major damage, so-called 'Black Swans');"

Now that risk has been generally defined as the outcome of the product of the probability a (negative) event occurs, and the impact of this negative event, and divided into categories, we should look closer into a definition for supply chain risks, as risk is a context specific definition (Spekman & Davis, 2004).

Juttner, Peck, and Christopher (2003) state that the term supply chain risk is used to both indicate the uncertainty of variables like customer demand, and the possible effects of these risks or i.e. "the consequences of risks becoming events". They define supply chain risks as "any risks for the information, material and product flows from original supplier to the delivery of the final product for the end user" and "the possibility and effect of a mismatch between supply and demand"(M. Christopher & Jüttner, 2000). They define the sources of risk as the unpredictable variables that could have an impact on the supply chain outcomes. Other articles underline the double use of the term supply chain risk; operational uncertainty and risk are used simultaneously in SCRM literature (O. Tang & Musa, 2011). O. Tang and Musa (2011)state that there are two important dimensions when referring to supply chain risks: "the outcome of risk impact and the expectation of risk sources" where impact is associated to a negative outcome. These dimensions show similarity to the two uses of the term supply chain risk as discussed by Juttner et al. (2003). However, the dimension of expectation is a contradictory one when looking back to the three different categories of risks as given by Manners-Bell (2014). The third category speaks of "unknown unknowns" and can therefore not be linked to expectation, making it difficult to provide a clear definition for supply chain risk(O. Tang & Musa, 2011). For this reason, O. Tang and Musa (2011) express that a definition should include low probability events with possible abrupt occurrence which have a negative effect on the overall supply chain. However, this would exclude the risks that follow from uncertain variables as demand, and can therefore not be considered a fully comprehensive definition. Heckmann et al. (2015) dedicated an article to filling the gap of a clear definition for supply chain risk. The definition they provide states that "supply chain risk is the potential loss for a supply chain in terms of its target values of efficiency and effectiveness evoked by uncertain developments of supply chain characteristics whose changes were caused by the occurrence of triggering events" (Heckmann et al., 2015). This definition is applicable to all type of risk categories, and it includes the sources of risks as well as the impact. Therefore, this research adapts the definition for supply chain risk as given by Heckmann et al. (2015).

Sources of supply chain risks As discussed in Heckmann et al. (2015), most researchers define supply chain risks through categorizing them according to source of risk. The variation in these categories shows the absence of consensus on these risk categories (Sodhi et al., 2012). Spekman and Davis (2004) consider the three supply chain flows of material, finance and information as the three sources of risk together with the security of information, the relationships among supply chain partners and corporate social responsibility. O. Tang and Musa (2011) make a similar distinction and provide a more detailed categorized within the tree supply chain flows as sources of risk. Another example of such a categorization is given by Waters (2011). He makes a very broad distinction between internal and external risks. Where internal risks appear within the normal operations and external risks come from outside of the supply chain. But stating that the distinction of internal and external is difficult to apply in practice, he opts for another distinction. He describes risks as “internal risks” which either are inherent or arise more directly from management decisions, risks within the supply chain, or risks in the external environment. Another example is provided by Chopra and Sodhi (2004). They provide an extensive list of risk categories including disruptions, delays, systems, forecast, intellectual property, procurement, receivables, inventory and capacity. Juttner et al. (2003) on the other hand, only names three sources of supply chain risks, supply, demand and environmental. Another distinction is made by Wagner and Bode (2006), who identify demand side, supply side, regulatory, legal and bureaucratic, infrastructure and finally catastrophic. Zsidisin (2003) classifies supply chain risks based on sources and outcomes. The sources are categorized into “individual supplier failures” like delivery failures, relationship issues and quality problems and “market characteristics” like limited qualified sources and market shortages. The outcomes are subdivided into the categories “the inability to meet customer requirements” like missed shipments and “threats to customer life and safety” like product liability.

The categories as proposed by the different authors show a lot of similarities. There are a number of categories that reoccur in a number of articles.

- External (or environmental) vs. Internal
- Demand and supply risks
- Accidents/catastrophe/disruption vs. others

It can be stated that some authors seem to use a higher level of categories than others. For example, C. S. Tang (2006) and Waters (2011) only identify two different categories in contrast to the six categories by T. Wu, Blackhurst, and Chidambaram (2006). This paragraph aims to combine and link the different categories to each other, in order to create a complete overview of the categories of sources of risk from the viewpoint of an inland terminal. For this overview we adopt the categorization internal and external, as well as a disruption risk versus an operational risk as a high level categorization. Any internal risks come from within the focal organisation, which in this case is considered to be Alpherium. Some risks can be part of both high level categories. The supplier can be considered both the shipping companies (supplier of material) as well as the terminal operators (supply of containers goes through the terminals). Demand is created at HNS.

Table 2-1 aims at combining the risks as discussed in literature in order to create a complete and clear overview. The input for this categorization can be found in Appendix A. This categorization is applicable to a SCRM in practice from the viewpoint of the inland terminal with a load centre role and port to inland structure (Van den Berg & De Langen, 2015). The inland terminal is considered the focal point, and thus the source of internal risks. Another possible practice is looking at the supply chain in total or a part of the supply chain in total as source of internal risks (Heckmann et al., 2015).

Table 2-1: Defined risk categorizations

	Internal Risks	**External Risks**
Operational Risks	Infrastructure risks Process risks • E.g. Human errors Control risks	Demand and supply uncertainty • Demand risks ◦ E.g. Forecast inaccuracies • Supply Risks
Disruption Risks	Accidents Intentional disruptions	Accidents Natural hazards Intentional disruptions

2-1-2 Supply chain disruptions

Now that we have defined a supply chain risk and discussed the different sources of risk, the term supply chain disruption will be discussed in more detail. A supply chain disruption is defined as “an event that takes place at one point in the chain and can adversely affect the performance of one or more elements located elsewhere in the supply chain and the normal flow of goods and materials within a supply chain”(Behdani, 2013). A supply chain risk considers the likelihood and possible impact of the occurrence of a disruption (Behdani, 2013). The impact of a disruption can be immediate, but it can also take time before the impact is fully noticeable on the supply chain performances (Sheffi & Rice Jr, 2005). A disruption or failure somewhere in the supply chain could result in the failing of an entire chain and or amplified effects that can harm other participants within the chain (T. Wu, Blackhurst, & O’grady, 2007). In contrast to a risk, which stands for the likelihood and expected impact, a supply chain disruption considers an actual event. A risk is thus the likelihood and expected impact of a possible disruption.

In the risk categorization in Table A-1, a distinction is made between disruption- and operational risks. Operational risks are related to uncertainties referring to demand and supply, e.g. forecast inaccuracies. Disruption risks are considered as the effect of “natural and man-made disasters such as earthquakes, floods, hurricanes, terrorist attacks etc. ”, which are expected to have a higher impact that the operational risks (C. S. Tang, 2006).

For this research, both categories are subject to the analysis as both can harm the supply chain performances. Both disruption risks and operational risks can result in a disruption within or to the supply chain, as an event can either be major or minor and happen occasionally or have an extremely low possibility. Therefore, a distinction between operational and disruption is only made in risk categorization. When referring to a disruption, it can be the result of both a disruption and an operational risk.

2-1-3 Supply Chain Risk Management and supply chain disruption management

According to Behdani (2013), there are two main views on how to handle supply chain disruptions: pre-disruption and post-disruption. Pre-disruption is linked to SCRM and post-disruption is linked to supply chain disruption management. Literature on SCRM seems to confirm this categorization (Chopra & Sodhi, 2004; Giannakis & Louis, 2011; Spekman & Davis, 2004). SCRM is mostly focused on pre-disruption actions. SC-disruption management focuses on actions required to deal with the impact of a disruption after it occurred. Behdani (2013) states that both management processes should not be perceived separately but be integrated and interconnected.

Behdani (2013) speaks of an overall agreement on three SCRM-steps, underlining the division of pre-disruption and post-disruption handlings. Where the steps described below focus on pre-disruption and thus SCRM.

1. Identifying risk factors in a supply chain;
2. asses the level of risk;
3. select and implement necessary treatments.

(Sodhi et al., 2012) described the four key elements for managing supply chain risks a little different. These elements are:

1. Risk identification;
2. Risk assessment;
3. Risk mitigation;
4. Responsiveness to risk incidents.

It shows that Sodhi et al. (2012) do not make the same distinction as Behdani (2013) and combine pre- and post-disruption management (responsiveness to risk incidents) within SCRM as an integrated process.

Considering SC-disruption management actions, adopting the idea of pre- and post-disruption views, these actions can be divided into three categories:

1. Disruption discovery
2. Disruption recovery
3. Supply-chain redesign (J. Blackhurst et al., 2005).

Pyke and Tang (Cited in Behdani (2013)), like Sodhi et al. (2012), elaborate on an integrated approach to managing risks and disruptions. Their approach is based on three stages: “Readiness, Responsiveness and Recovery”.

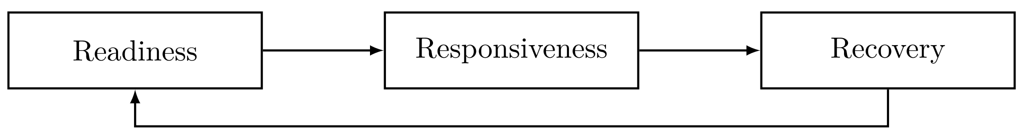

Figure 2-1: The 3R framework for mitigating product recall risk (from Pyke and Tang, retrieved from Behdani (2013)

As can be seen in Figure 2-1, the 3R framework clearly shows that readiness for and recovery of a disruption are related, which can be considered as the link between pre- and post-disruption management. However the lack of details makes it more a directive inspiration, than a useful tool. Behdani (2013) presented his "Integrated Framework for Managing Disruption Risks in Supply Chains" in order to fill the gap of a framework combining both pre-and post-disruption management. This framework consists of a risk management cycle that is focused on "discovering potential disruptions and prevent them from becoming actual disruptions", and a disruption management cycle aimed at "handling the actual disruption once it has occurred and to use that experience to learn so as to avoid, reduce or transfer the risk of happening similar potential disruptions in the future"(Behdani, 2013).

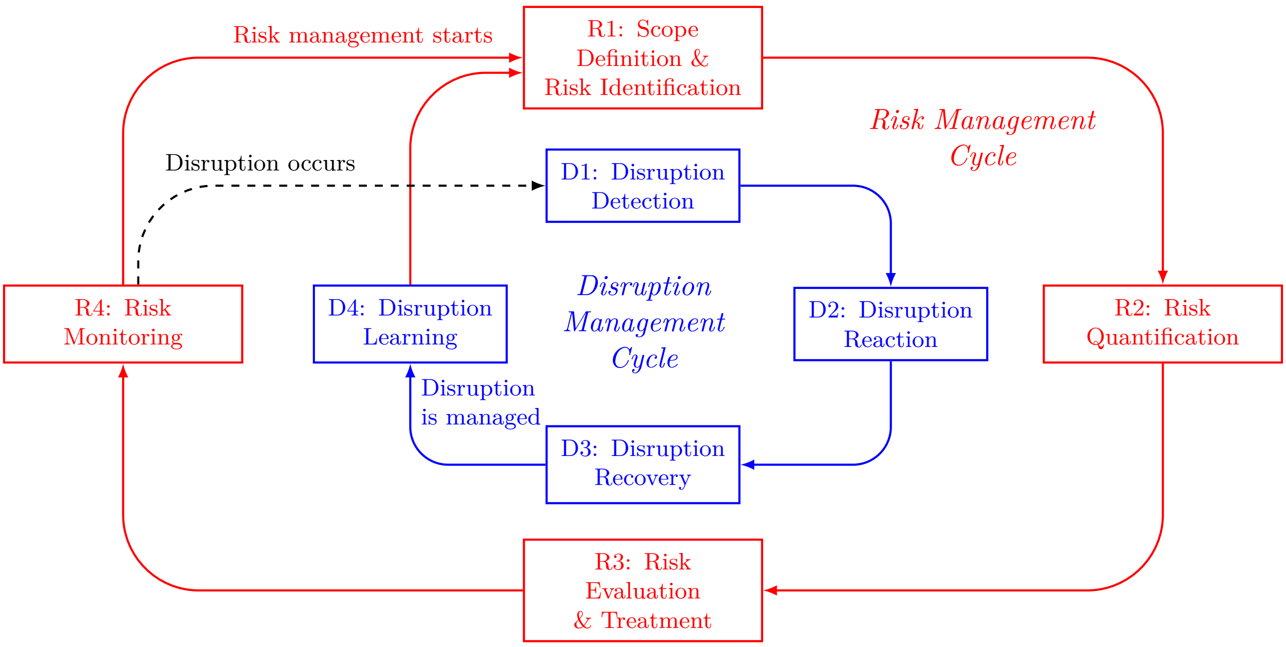

Figure 2-2: The integrated framework for managing disruption risks in supply chains. Retrieved from Behdani (2013)

Figure 2-2 shows the overall structure of the framework. This framework will form the basis for the research framework used to analyse risk and disruption management at an inland terminal. As Behdani (2013) stated, his framework filled the gap of an incorporation of both pre-and post-disruption views, and is therefore unique in its kind

2-1-4 SCRM, SC-disruption management and decision making

As stated above, in general SCRM consists of the step selecting and implementing necessary treatments or mitigating actions to deal with the identified risks (Behdani, 2013). In a way these can be considered as strategic decisions, as the assessed risk levels in combination with the sources of risk form the input for a trade-off decision that results in mitigating actions (Juttner et al., 2003). Decision makers have to weigh the costs of e.g. extra inventory against the probability of running out of stock, or a reliable supplier with higher costs against a unknown supplier with lower costs (Juttner et al., 2003). This decision making process is challenging as the uncertainty of vulnerable supply chains can make it difficult to come up with an optimal decision since consequences are not always certain (H. Christopher & Peck, 2004; Zsidisin & Ritchie, 2008). This research focuses at evaluating these strategic decisions. A short overview of possible mitigations actions is provided based on recurrence in literature.

- Implementation of buffer stock or increase of inventory
- Using multiple or redundant suppliers
- Use of specific type of risk sharing contracts
- Increase of capacity
- Aggregate demand
- Avoiding specific customers/supplier/environments
- Sharing of risk-related information (Chopra & Sodhi, 2004; Juttner et al., 2003; Spekman & Davis, 2004; C. S. Tang, 2006).

As most risk mitigating actions are strategic decisions, it is assumed they are often made over a relative longer period of time and decision makers therefore have the opportunity to seek additional information in order to find a close to optimal solution. This is not the case for SC-disruption management. If a disruption takes place, supply chain partners should respond as quickly as possible to minimize the impact (Datta & Christopher, 2011; Sheffi & Rice Jr, 2005). A lack of visibility and uncertainty about the current state of the overall system forms a barrier to making fitting decision steps (Behdani, 2013). Therefore, the information flow should be as accurate and complete as possible in order to keep all those involved updated (O. Tang & Musa, 2011).

2-2 The challenges of inter-organizational collaboration

The case study concerns a supply chain partnership between Alpherium and Heineken Nederland Supply (HNS). As stated in the introduction, the goals of this partnership are to secure supply, reduce transport costs, improve transport optimization and reduce harmful emissions. For two independent organizations to collaborate, mutual benefits should arise from it (Barratt, 2004). In this particular case, Alpherium provides transport and stock capacity of empty and loaded containers as well as the required transport handlings to HNS. HNS is accountable for approximately 90% of all handlings performed at Alpherium, and is therefore its major customer. Alpherium is the only option Heineken has for multi-modal transport in the area resulting in a interdependency between the two parties.

2-2-1 Inter-organizational collaborations

SCRM is a collaboration among supply chain partners (C. Tang, 2006). According to Barratt (2004), there are two main categories of supply chain collaboration; vertical and horizontal collaboration. Vertical collaboration includes external collaboration with customers and suppliers or internal collaboration. Horizontal collaboration consists of collaboration with competitors and non-competitors, external or internal Figure 2-3.

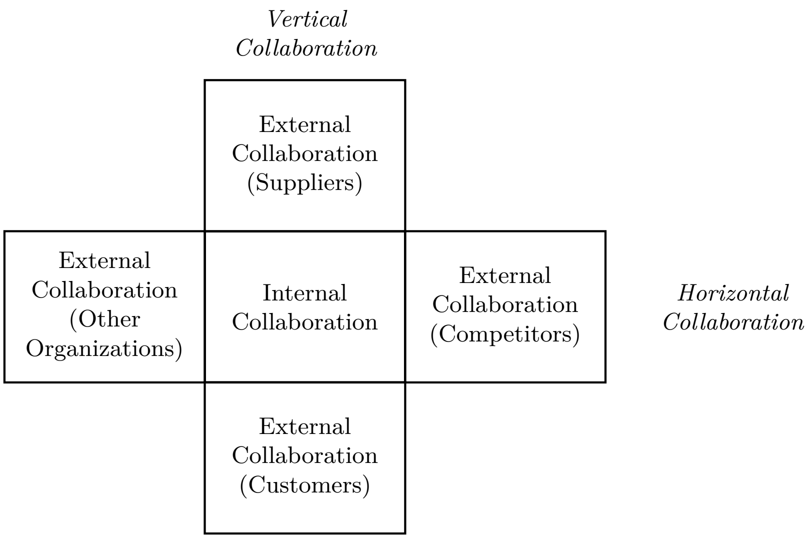

Figure 2-3: The scope of collaboration: generally. Retrieved from Barratt (2004)

How can the collaboration between Alpherium and HNS be characterized? Alpherium can, in a way, be seen as a supplier. Even though Alpherium is not a supplier of a product manufactured by its own company, the terminal takes care of the supply of empty containers to the brewery in Zoeterwoude. They supply transport and capacity for the handlings and stock of empty and loaded containers. Since Alpherium and HNS are not part of the same organization, it can be stated that their collaboration is an external supplier collaboration. External collaboration can be referred to as inter-organizational collaboration. It has multiple characteristics that should be taken into account if such a collaboration should lead to mutual benefits and reach the established goals of the specific collaboration.

In any supply chain, information sharing is a key ingredient (S. Li & Lin, 2006). Through sharing information with supply chain partners, the information flow can be improved and so enhance the supply chain's efficiency, effectiveness and responsiveness. For effective information sharing, information quality with aspects like accuracy and timeliness is of great importance. The degree of impact of sharing information depends on what information was shared, when it was shared, with whom and how. However, in an inter-organizational context, information sharing or knowledge sharing is hampered by different barriers (S. Li & Lin, 2006). In some cases information sharing is limited deliberately because the possession of information can be linked to power, an influential position or a professional advantage over others (Hatala & Lutta, 2009). Sharing information could also be limited due to fear of opportunistic behaviours from the partner as a result of a lack of trust (Kersten, Hohrath, & Böger, 2007). Although understandable, these mechanisms can negatively affect the collaborative performances in a supply chain (Bock et al., 2005; Lee & Whang, 2000; L. Li, 2005; S. Li & Lin, 2006).

2-2-2 Defining information and knowledge sharing

Extensive literature exists about knowledge- and/or information sharing within an inter-organizational collaboration. In some cases both definitions are used interchangeably, in other cases authors use only one definition. Before we go into further detail about knowledge sharing or information sharing barriers, it should be clear what these definitions stand for and which of the two definitions is most fitting to the collaboration of the case study.

According to De long and Fayeh (2000) a distinction between data, information and knowledge can be made. They view data as "raw or unabridged descriptions or observations about states of past, present, or future worlds" and information as "patterns that individuals find or imbue in data". Knowledge is described as a product of "human reflection and experience" (De long & Fayeh, 2000). Knowledge is often subdivided into explicit and tacit knowledge. Tacit knowledge is knowledge acquired without conscious efforts or in-explicit knowledge and is the result of an individual's experiences (Reber, 1989). Explicit knowledge "can be clearly articulated in written documents" (Yang & Chen, 2007).

Knowledge sharing according to Yang and Chen (2007) is "depicted as a set of behaviours about knowledge exchange which involve the actors, knowledge content, organizational context, appropriate media, and societal environment". It is stated that effective knowledge sharing consists of transmission and absorption between a knowledge owner and a recipient, where the knowledge owner uses the skills of codification, elaboration and presentation to transmit knowledge to the recipient who reconstruct this knowledge according to his capabilities (Yang & Chen, 2007). Easterby-Smith, Lyles, and Tsang (2008), define the transfer of knowledge as an event where organizations learn from the experience of another organization.

Articles written from a SCM background often speak of information sharing, without explicitly defining a definition for information or information sharing. Information is described as one of the flows that moves through a supply chain, alongside to material and financial flows (Fiala, 2005; Lee & Whang, 2000). Therefore it is assumed that from a SC-perspective, information sharing can stand for various forms of information or knowledge.

Taking the collaboration between Alpherium and HNS into consideration, and looking specifically at the definitions for knowledge- or information sharing, we assume that both definitions can be applicable to the case study. Being part of a supply chain, the two parties naturally share information on demand forecasts, expenses, progress of transport, etc. In most cases, this can be seen as the patterns that are found in data (De long & Fayeh, 2000). On the other hand, in the case of a supply chain disruption, experience of those involved becomes important. In some cases, e.g. if the barge planner at Alpherium is notified about a heavily congested terminal he will need to adapt the barge planning as it could harm the CA; in other cases he might not have to. The planner would then use this information, combine it with his (tacit) knowledge and experience, and pass it on to HNS. In this case, sharing of information would be insufficient because HNS would not understand what the effects of the congestion could mean for them. Therefore, in the case study covered by this research, both terms are deemed applicable. Considering the fact that this research is partly based upon a study field of logistics, linked to SCM, it will be referred to as information.

2-2-3 Partnership performance indicators

The importance and effect of information sharing in supply chain management has been extensively underlined in literature (Cachon & Fisher, 2000; Fiala, 2005; S. Li & Lin, 2006; Sodhi & Son, 2009). However, as stated earlier, sharing of information within a supply chain, and especially as a part of inter-organizational collaboration, can be made difficult due to information sharing barriers.

According to Yang and Chen (2007), important conditions or impediments for information sharing are: culture, organizational structure, information communication technology, and incentive system and staff turnover. S. Li and Lin (2006) state that “the extent to which critical and proprietary information is communicated to one’s supply chain partner” and the information quality depend on supplier uncertainty and the inter-organizational relationship aspects: trust, commitment and shared vision. Barratt (2004), on the other hand categorizes relationship specific assets together with information exchange, openness and communication as a part of a collaborative culture. Sodhi and Son (2009) use a similar categorization where partnership performance is influenced through information exchange, trust, joint partnership management, relation specific assets and partner asymmetry. They make a distinction between strategic and operational partnership performances. L. Li (2005), like Yang and Chen (2007) added organizational culture as an influential factor to information sharing.

These researchers, discussed above, seem to agree upon the fact that partnership performances are influenced by both relational factors as well as the manner and frequency of information sharing. However, some state that collaborative performances are directly influenced through relational aspects, while others see the effect of relational aspects on collaborative performances indirectly through information exchange between supply chain partners. In this research we adopt the categorization made by S. Li and Lin (2006), as it is directly related to supply chain literature and considered as one of the most comprehensive approaches. Combined with the approach of Sodhi and Son (2009) and Barratt (2004), this results in the following framework.

A frequently referred source for the theoretical foundation of inter-organizational challenges is S. Li and Lin (2006). Considering that during this project the source was approximately 10 years old, we looked into other articles citing (S. Li & Lin, 2006) to find out if their theories were refuted. We found a number of articles that cited the source without contradicting, which let’s us to assume the source remains relevant today (Rajaguru & Matanda, 2013; Liu, Ke, Kee, & Hua, 2013; Olivier, Angappa, & Alain, 2012).

The different indicators and the relationships between the indicators are discussed in detail below.

Environmental uncertainties

We include here only the environmental uncertainties that are considered to be attached to the partnership between HNS and Alpherium. Environmental uncertainties can be divided into customer and supplier uncertainties and are therefore directly linked to supply chain risks. These environmental uncertainties bring challenges that should be faced by the supply chain partners in order to attain the partnership’s performances as agreed upon beforehand (Rajaguru & Matanda, 2013; Wei, Wong, & Lai, 2012). Customer uncertainty is “the extent

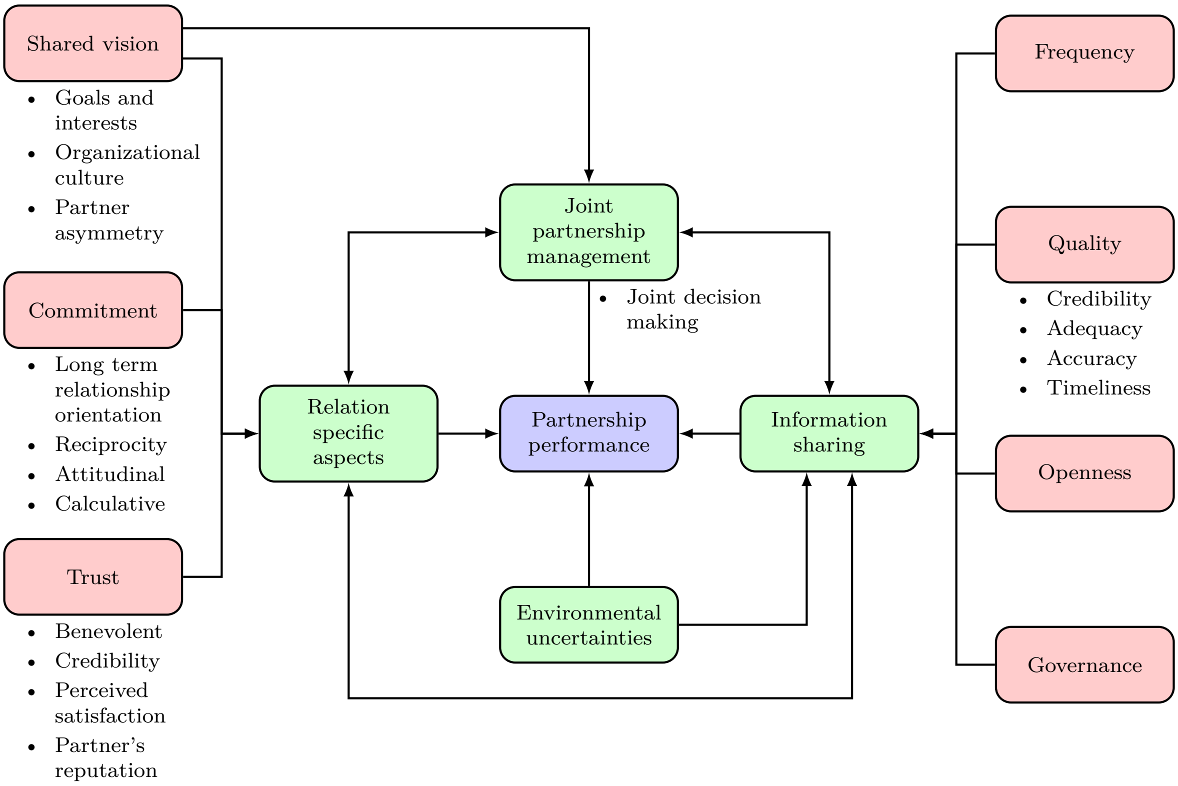

Figure 2-4: Partnership performance indicators

of the change and unpredictability of the customer's demands". Supplier uncertainty is "the extent of change and unpredictability of the suppliers' product quality and delivery performance" (S. Li & Lin, 2006). Environmental uncertainty is considered a driver for sharing high quality information. Thus the higher the environmental uncertainty, the higher the need for information sharing (S. Li & Lin, 2006; Wei et al., 2012; Rajaguru & Matanda, 2013). However, others have stated that suppliers with high uncertainty are considered too risky to share information with (S. Li & Lin, 2006). It is assumed that this is related to a low level of trust in the supplier as a relationship-specific asset from a supplier-customer relationship.

Joint partnership management

Another driving factor behind a partnership performance is joint partnership management. A joint partnership management stands for "a well-defined structure for developing, maintaining and monitoring collaborative inter-firm arrangement". Joint decision-making can be a part of a joint partnership structure (Sodhi & Son, 2009).

Inter-organizational relations

According to S. Li and Lin (2006), organizations lacking a good inter-organizational relationship built on trust, commitment and shared vision will be hesitant to share information. In order to get an insight into the inter-organizational relationship between HNS and Alpherium, the factors trust, commitment and shared vision are examined in more detail.

Trust Trust is described by many researchers, resulting in a variety of definitions and meanings. For the analysis of the inter-organizational relationship between HNS and Alpherium a distinction is made between benevolent trust and credibility trust or behavioural uncertainty. Benevolent trust is defined as "the belief that an alliance partner will behave with goodwill toward the alliance and the partner" (Cullen et al., 2000). Credibility trust is described as "the rational component of trust, the confidence that the partner has the intent and ability to meet their obligations and make their promised contributions to the alliance. It concerns beliefs about whether or not a partner can really deliver what they promise" (Cullen et al., 2000). Credibility trust is closely related to behavioural uncertainty which is described as "the inability to predict a partner's behaviour or changes in the external environment" (Kwon & Suh, 2004). A partner's reputation supports the growth of trust between partners, as well as the perceived satisfaction of the prior collaborative outcomes (Kwon & Suh, 2004).

Commitment Strongly related to trust is the level of commitment between supply chain partners. Commitment, like trust can be divided into two categories; calculative and attitudinal commitment (Kwon & Suh, 2004). Calculative commitment can be seen as a result of the existence of cost benefits for the partners, and is therefore called the "economic side of commitment" (Cullen et al., 2000) Attitudinal commitment relates more to the emotional side of commitment. According to Cullen et al. (2000), "the alliance assumes a position of status and importance; the partners are willing to care for it". The presence of only calculative commitment can have a negative effect on the partners' relationship as it could inhibit the development of the relationship. The combination of both forms of commitment is expected to have a positive effect on the partnership (Cullen et al., 2000). Reciprocity is added to the factors that determine the level of commitment. It is stated that "a partner receiving a valued contribution in an exchange behaviour develops a sense of obligation and reciprocates with appropriate responses in a justice manner"(I. L. Wu, Chuang, & Hsu, 2014). Commitment can be the result of long-term relationship orientation. Paulraj, Lado, and Chen (2008) describe the importance of a long-term relationship orientation as an important condition for collaborative communication and relationships. They state that by having a long-term orientation, supply chain partners can rely on "understandings and conventions involving fair play and good faith", which can also be related to trust.

Shared vision Shared vision can refer to shared organizational values, goals and culture. Compatible cultures and ideas support coordinative actions and supports sharing information in the form of communication (S. Li & Lin, 2006). Organizational culture can "create the context for social interaction that determines how knowledge will be used in particular situations, it determines how information is retrieved and distributed " (De long & Fayeh, 2000). Different cultures require different ways of information outputs (Drake, Steckler, & Koch, 2004), and can lead to partner asymmetry (Sodhi & Son, 2009).

Sharing of information

As stated earlier, alongside inter-organizational relationship assets, the outcomes of supply chain partnerships heavily depend on sharing of information. The positive effect of information sharing is influenced by the quality of information and the frequency of information sharing.

Frequency According to Sodhi and Son (2009), “frequent exchange of information on strategic and operational matters may foster greater confidence, build cooperation and trust, reduce dysfunctional conflict and, thus, generate relational rents”.

Quality of information The quality of shared information depends on several factors including “accuracy, timeliness, adequacy and credibility of information exchanged” (S. Li & Lin, 2006). A lack of high quality information could result in information distortion or delay which could harm the decision making process.

Openness In addition to frequency and quality of information sharing, openness can also be considered as an important aspect of information sharing as it can be interpreted as a signal of trust (Kwon & Suh, 2004).

Governance In order to attain high levels of information quality, sharing frequency and openness, a well-structured governance, which will also support the decision making process, is necessary. In general, situations that deviate from “normal” are characterized by a “high degree of uncertainty and lack of accurate information” (Chen et al., 2010), especially in an early stage (Behdani, 2013). In a situation where there is a high risk of emerging disruption, or a disruption as a result of a high risk situation, there could be lack of clear communication structure. This can be problematic since continuous sharing of information between actors can strongly influence effective decision making (Behdani, 2013). As stated earlier, social factors like trust can influence the manner and degree of information sharing. Supporting information sharing in an early stage by considering social factors could help protect supply chain performances from risks and disruptions.

2-3 Robust planning and the critical chain method

Part of the inland terminal’s operation includes the creating and executing of a barge planning that determines when and where containers are loaded or unloaded at the deep sea terminals and depots. It is often difficult to execute the barge planning according to the pre-defined plan, due to changes and disturbances in the port environment (Douma, Schutten, & Schuur, 2009). This is one of the effects of the interdependency of terminals and barges. A delay at one terminal could result in a delay at others (Douma et al., 2009). This is a complex problem arising from a number of different factors e.g. independent barge operators tend not to share information with each other and therefore cannot plan collaboratively; the lack of contractual agreements between barge and terminal operators; and a highly dynamic environment (Douma et al., 2009). The barge planning must therefore be executed in a highly uncertain environment.

Uncertainty is often referred to as a lack of information, and in order to reduce uncertainty one should seek and process additional information (Walker et al., 2013). However, in this case, additional information is not always accessible because of several restrictions. Walker et al. (2013) suggest four different ways to deal with uncertainties.

- Resistance: plan for the worst possible case or future situation;
- Resilience: whatever happens in the future, make sure that the system can recover quickly;
- Static robustness: aim at reducing vulnerability in the largest possible range of conditions;
- Dynamic robustness (or flexibility): plan to change over time, in case conditions change.

The first way, resistance, is considered useless for the barge planner as it is expected to be costly and likely to result in a very inefficient use of barge capacity. A robust plan is "defined to be one that yields outcomes that are deemed to be satisfactory according to some selected assessment criteria across a wide range of future plausible states of the world". A resilient plan aims at dealing with uncertainty by accepting short term losses and focusses on recovery (Walker et al., 2013).

A planner could always choose to not take into account the uncertainty and create an optimal plan. An optimal plan will show best results in an uneventful future, but has a harder time dealing with alternative circumstances and therefore uncertainties (Walker et al., 2013).

Although Walker et al. (2013) discuss uncertainties of a long term planning, and a barge planning usually does not exceed more than a week, it is assumed the barge planning could be approached similar, as it deals with a high number of uncertainties, for which additional information is not available when the plan is being made.

Figure 2-5 aims to provide a schematic view of the difference between optimal and robust planning. The y-axis shows the quality of the planning. In the case of the barge planning a high quality is the most efficient use of the barge capacity while supplying demand. The green line shows the relation between an optimal plan, the planning quality and the flexibility of the plan. The blue line depicts the relation between a more robust plan and the planning quality. As the figure shows, the achievable quality of an optimal plan is higher than the achievable quality of a robust plan, as the maximum of the green line shows the optimal planning. This means the barge capacity can be used more efficiently, resulting in a cost reduction. However, the optimal planning is more vulnerable than the robust planning, as can be seen in Figure 2-5. The chance of achieving an overall higher quality with the robust planning is higher than with the optimal planning, where an event could quickly decrease the quality of the planning and move further away from the optimum. Dealing with uncertainties, robust planning could be the better choice as a disruption could result in lowering the quality of the optimal planning.

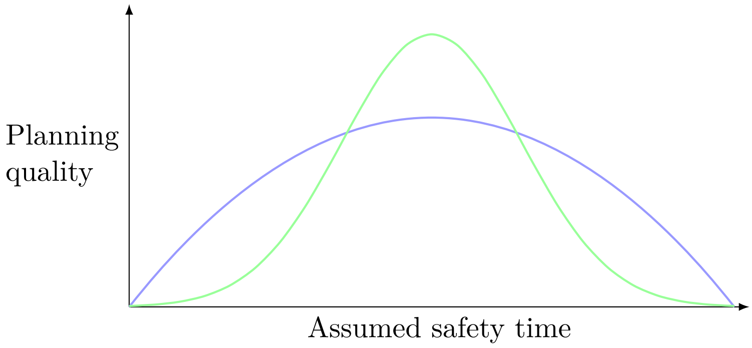

Figure 2-5: Robust vs. optimal planning

The barge planning at Alpherium is usually made for five or six barges, depending on the demand from HNS. Each barge is assigned with a number of round trips. The round trips consists of a trip to a deep sea terminal to drop off a number of loaded containers, in most cases a trip between deep sea terminal and depot to pick up the empty containers, and the trip back to Alpherium. This means every barge has to complete a number of round trips within one week in a pre-defined order. This planning problem shows similarities to project management and can therefore be linked to the use of the critical chain method. The critical chain method was first introduced by (Goldratt, 1997). The method uses the application of the Theory of Constraints theory of constraints (TOC) on project management. The TOC is focussed on identifying the bottlenecks of a process, and when these are found, exploiting these bottlenecks (Bevilacqua, Ciarapica, & Giacchetta, 2009).

The critical chain method is used to plan different process or supply chain steps aiming at an efficient and realistic planning considering the different time steps. The critical chain, in contrast to the critical path method, takes into account the resource availability along the different process steps. The critical path method, an example of a traditional project management planning method, does not take into account the fact that some resources cannot be scheduled to perform two activities at once. The critical chain method does, and reflects the resource availability in the expected project completion time (Bevilacqua et al., 2009; Rand, 2000; Herroelen & Leus, 2001). Considering the barge planning, the resources can be linked to handling appointments at the deep sea terminals and depots and at Alpherium. These appointments require space, labour, material and time.

Besides the resource availability, the critical chain methods differs from traditional project management techniques when it comes to determining process step times and buffer time use (Bevilacqua et al., 2009). Goldratt (1997) introduces the use of a safety time buffer. Instead of implementing a safety time after each activity, as with the Critical Path or Pert method (Bevilacqua et al., 2009), a safety time buffer is strategically located in such a way the critical chain will not be delayed and that there will not be a misuse of safety time (Rand, 2000; Tukel, Rom, & Eksioglu, 2006). Goldratt (1997) describes how psychological factors are the cause of projects being overrun when each activity has incorporated a safety time within its total planned duration. One factor is the so-called 'student syndrome', meaning that because the employees are aware of the safety times, they start late. Another factor he mentions is that preparations will not be made before the previous activity has finished, resulting in a delayed start. The third factor is that even if an activity is completed early, it will not yet be released to prevent from receiving less time for the activity in the future (Rand, 2000). Others also mentioned Parkinson's law, stating that "work tends to expand to fill the time available" (Blackstone, Cox, & Schleier, 2009; De long & Fayeh, 2000). It is therefore important, that safety times are strategically placed an not overestimated to prevent the available time being used inefficiently.

Underlining this assumption is the "Theory of Goal setting and Task Motivation" by Locke and Latham (2002). Goals are defined as as "the aim of an action..within a specified time limit" (Locke & Latham, 2002). It is stated that "the force to act is a multiplicative combination of anticipated satisfaction, the belief that performance will lead to rewards and the belief that effort will lead to the performance needed to attain the rewards" , depending on the difficulty level of a certain task (Locke & Latham, 2002). Goals are believed to have a directive function and if the actual goal is lower than the goal of a pre-defined plan, thus if the safety time is higher than required, the employees or shippers are expected to try the fill up this safety time, and will not be motivated to decrease process step times **(source)**. Lower goals also result in less overall effort, decreasing the chance of attaining the higher goals the next time. Locke and Latham (2002) discuss the fact that lack of importance of attaining the goal plus the belief in goal attainability can limit the commitment of those executing the tasks. It is therefore assumed that if employees are not triggered to finish early or in another case, there would be not enough time, considering the time planned per process step, commitment could decrease. According to the theory of Locke and Latham (2002), the lack of low goal setting could lead to a negative feedback loop. The set goal is low, which leads to weaker performances, resulting in a lack of reward. A lack of reward limits the satisfaction and self-efficacy of those responsible for attaining the goals. The lack of self-efficacy prevents them from "meeting future challenges through the setting of even higher goals"(Locke & Latham, 2002). Thus a high safety time buffer, prevents the employees from finishing early and could enforce Parkinson's law and decrease efficiency, but too little safety time can lower commitment.

The safety time buffers in the critical chain method are a way of dealing with uncertainty. The project manager does not assume all activities to be finished in the estimated time steps, and therefore incorporates possible delay of activities within the planning. For this research we link the critical chain method to the robustness of a barge planning. The case study analysis can help provide an insight into the current barge planning methods, and help to find out whether or not there is room for improvement.

Chapter 3

Research framework & methodology

3-1 Research framework

This research project combines a case study research strategy with a research framework based on the integrated framework on handling supply chain disruption risks (Behdani, 2013). This chapter starts with describing the integrated framework on handling supply chain disruptions and risks, followed by an elaboration on the case study research strategy.

3-1-1 Integrated framework of SCRM and SC-disruption management

The integrated framework makes a distinction between risk and disruption management. The research framework adapts this distinction and starts with risk management.

- Risk management

R1: Scope Definition & Risk identification The first step of the integrated framework is to identify the system and its boundaries as subject to the supply chain risk and supply chain (SC)-disruption management. Part of the system definition is the indication of the critical objective and the related performance indicators. A disruption can be classified as a SC-disruption when it impacts the critical objective and performance indicators. When the system and the critical objective are defined, the different supply chain risks can be listed. These risks can be found based upon historical data, literature review and desk research.

R2: Risk quantification The second step of the risk management cycle aims at evaluating the expected impact on the critical objective and related performance indicators of the listed supply chain risks found in the previous step. This includes the expected likelihood of the different risks and the expected impact of the listed risks. Together these form the so called risk level of the different supply chain (SC)-risks (Behdani, 2013).

R3: Risk Evaluation & Treatment The previous step functions as the input for the third step of the risk management cycle. Here the established risk levels linked to the listed SC-risks are evaluated in order to determine if mitigating actions are in order or if the risk levels can be considered acceptable. The considerations taken before implementing a mitigating approach are related to costs and expected gains of different options, including no action. The effect of mitigating actions on other SC-risks should be taken into account as well. E.g. buffer stock can prevent stock outs but comes with stock costs and could bring a risk of spoilage of the products (Behdani, 2013).

R4: Risk monitoring The final step follows when mitigating actions have been implemented. Changes in the environment, or adaptations of the system could affect both the system's boundaries and the evaluated risk levels. Besides, after implementation, mitigating actions could prove not to be sufficient or over time risk levels might show to be estimated incorrectly. Therefore, an organization should adapt an active attitude and monitor and re-evaluate current Supply Chain Risk Management (SCRM) continuously over time. Besides, SCRM is not expected to prevent an organization from all risks, resulting in so called residual risk, which should be monitored closely (Behdani, 2013).

- Disruption management

D1: Disruption detection The first step of disruption management is to make sure that a disruption can be detected as quick as possible. In some cases, a disruption can be detected as it is observed within the operational system. If this is the case, those involved should be informed quickly, then the impact of the disruption can be assessed. In other cases, a disruption could come to sight through the performances of a system. This would mean the cause of the disruption is unknown at first and should be found.

D2: Disruption reaction After a disruption is detected, it is important to react fast in order to return the system to its desired state. In some cases, during the treatment stage of the SCRM-cycle, disruption plans could have been pre-defined. This could save time during the reaction period, which can be crucial in limiting the disruption's impact on the critical objective (Wagner & Bode, 2008). If the reaction limits the disruption's impact but does not bring the system back to its original state, the next step of the SC-disruption management cycle should be taken.

D3: Disruption recovery As stated above, this step is only activated when disruption reaction is not sufficient to bring back the supply chain to its desired state or when there was no predefined plan. During this stage it is very important that the actors involved continuously monitor the disruption and gather information, as well as keep in close contact with the supply chain partners involved. Disruption recovery and disruption reaction can take place simultaneously.

D4: Disruption learning The fourth step in the SC-disruption management cycle links the disruption management cycle to the SCRM cycle. During and after a disruption, it could be that the organization needs to update the assessed risk levels or add a risk to the current list of identified SC risks. The step also entails the testing of a predefined plan and can evaluate its sufficiency, and if necessary adapting the plan. In some cases a disruption could even become a motivation to redesign (parts of) the supply chain (J. Blackhurst et al., 2005)

As stated earlier, risk management is already part of the collaboration between Heineken Nederland Supply (HNS) and Alpherium. This research uses the integrated risk and disruption management cycle to evaluate current SCRM and SC-disruption management within the collaboration and to find potential gaps.

3-1-2 Case study research

The integrated framework for disruption risk management is combined with a case study research strategy. A case study can fulfil different roles, as it can be exploratory, descriptive or explanatory (Yin, 2013). A case study is described as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clear" (Yin, 2013). The case study functions as input for this research. Desk research at HNS and Alpherium can provide insights into the collaboration between an inland terminal and shipper, and how they manage SC risks and disruptions.

3-2 Research Methodology

In order to provide a clear insight in how the main research question will be answered, all sub-questions are discussed below as well as the methods that will be used answering these questions.

The first sub-question states:

1 *What are the possible supply chain risks to the empty container availability at an inland terminal considering both information and material flows and what are the related risk levels?*

In order to answer the first question, a desk research is performed at HNS and Alpherium to collect information about the overall process. Desk research is done through stakeholder interviews as well as a historical data research on past disruptions. When the overall process is made clear, and data about past disruptions is collected, the information is combined with an in-depth literature research about disruption risks in both material and information flows. The outcome will provide an overview of the different supply chain risks and the associated risk levels.

2 *What are possible mitigating actions that could deal with the identified supply chain risks?*

To answer sub-question 2, the outcomes of literature research, desk research and the stakeholder interviews are combined. The combined outcomes should provide an insight into the mitigating actions performed at Alpherium and HNS, and how these are implemented.

3 *How can supply chain disruptions at an inland terminal with a focus on empty container availability be managed in order to limit the disruption impact?*

The research framework described in the previous section, provides the steps that should result in solid SC-disruption steps. Based upon these steps, the current SC-disruption management practice at the case study is evaluated through desk research and literature research.

4 *What are possible challenges from an inter-organizational perspective that could limit the partnership performances and information exchange between inland terminal and shipper?*

Combining the theoretical framework constructed in the previous chapter, with the outcome of the stakeholder interviews, an analysis can be done to identify the challenges within the partnership between HNS and Alpherium. To do this, the different transcripts of the stakeholder interviews will be coded to link the stakeholders' answers and statements to theoretical concepts.

5 *How can supply chain risk and disruption management be implemented in order to address these inter-organizational challenges?*

To answer this final question, the output of the previous sub questions must be combined. Theory on inter-organizational challenges, as well as the outcome of the analyses on current SCRM, SC-disruption management and inter-organizational challenges at the case study address gaps and set the requirements for improved SCRM and SC-disruption management design. The insights and ideas of the researcher determine what this design will look like.

Combining the answers to the questions as stated above, helps to answer the main research question.

By answering the questions described above, the main research question can be answered. The methods used to perform the case study analysis are:

- Data collection
  - Literature research
  - Desk research
    - Semi-structured interviews
- Process methods
  - Value Stream Map
  - Coding (with help of the Nvivo software)
  - SCRM cycle of the integrated framework as proposed by Behdani (2013)
  - SC-disruption management cycle of the integrated framework as proposed by Behdani (2013) to analyse and evaluate current disruption management

The method of a Value Stream Map and coding of interviews are discussed below.

3-2-1 Value Stream Mapping methodology

A value stream map - is a schematic overview of all required actions that bring a product through all the main flows, and can represent the production flow from raw material to end product received by the customer or a design flow (Rother & Shook, 2003). It is mostly a supportive tool, that helps to show the material and information flows through (a part of) the supply chain, and forms the basis of an implementation plan (Rother & Shook, 2003). Like most other lean manufacturing tools Value Stream Mapping (or Process Mapping) is a method to search for- and identify waste (Pavnaskar, Gershenson, & Jambekar, 2003). It also supports eliminating waste in practice (Hines & Rich, 1997).

Value Stream Mapping is one of many lean manufacturing tools. In all cases lean manufacturing focuses on eliminating waste (Naylor, Naim, & Berry, 1999). It differs per tool if it functions as a supportive tool that identifies waste, measures waste or if the tool actually eliminates waste (Pavnaskar et al., 2003). Which tool to use depends on a number of different factors, e.g. the type and part of an organization using the tool, the product or resources they are applied to, type of operations etc. (Pavnaskar et al., 2003). In the classification scheme for lean manufacturing tools, Pavnaskar et al. (2003) compare different lean manufacturing tools on seven different levels. These levels are a system level, object level, operation level, activity level, resource level, characteristic level and the application level. The amount of different tools is too high to elaborate on within this project. Therefore we elaborate on the same five tools as Pavnaskar et al. (2003) used to demonstrate the use of the classification scheme, in order to substantiate the use of a Value Stream Map for this project.

Cellular layout - In a cellular manufacturing system (CMS), the machines are grouped into cells dedicated to a specific part “family”. The objective of CMS is to create maximum cell independence (Pattanaik & Sharma, 2009). When the arrangements of machines is based on this dedications, we speak of a cellular lay-out, often in a U or O shape (Pavnaskar et al., 2003).

Facility layout diagrams - The facility layout problem has to do with the “physical organization of a product system” (Meller & Gau, 1996). Optimal facility layout diagrams are most important in the beginning of the system design (Ertay, Ruan, & Tuzkaya, 2006). A facility layout diagram is a visual representation of the machine positioning (Pavnaskar et al., 2003).

Load levelling - Load levelling or production levelling focuses on coping with large fluctuations in customer demand. Pavnaskar et al. (2003) define it as “Assigning of work to al machines, cells, or lines to match the outputs to reduce idle time”.

Six Sigma - Six Sigma can be seen as a philosophy that sees a direct correlation between defects in any form or shape and customer satisfaction (Harry, 1998). The higher the Six Sigma value, the smaller the chance of having defects.

Considering the scope and goal of this project, information flows play an important aspect within the supply chain. Planning of production, loading and barges takes up an important role in the overall process. From the five lean manufacturing tools, VSM is the only tool to take into account the reliability of information as well as all other resources like materials, space and time (Pavnaskar et al., 2003). Furthermore a VSM includes the activities of all involved parties (Hines & Rich, 1997). Therefore the VSM offers the most complete tool for this project at this stage in the process.

The end goal of a VSM is to find and identify waste, in order to eliminate waste in the future state (Hines & Rich, 1997). As described, the VSM functions as a lean manufacturing tool where a lean process is subject of application (Naylor et al., 1999). In this specific case, the overall process does not fit perfectly within the boundaries of a "pure" lean supply chain. The inventory in such a supply chain is attempted to be as low as possible (Naylor et al., 1999), and even though the inventory at the brewery at Heineken is indeed set to be close to zero, the inventory of the overall process is not. Based on conversations with stakeholders and scoping the problem, it can be said that reliability or robustness is valued higher than the elimination of waste. Therefore this research only includes the VSM process as a method to map the current situation in detail.

3-2-2 Coding of interviews

In order to organize data retrieved from the stakeholder interviews the process of coding is applied. The technique used is a predominantly closed coding. Open coding aims at creating concepts, that can later be grouped into categories in order to create a grounded theory (Bryman, 2015). Closed coding, on the other hand, aims at finding proof for theoretic concepts (Bryman, 2015). For this research a mixed method was chosen as a result of the interview structures. The interviews were conducted without a strong theoretical foundation and therefore do not give clearly theoretical related outcomes. Considering the fact that in order to identify the social factors influencing the supply chain partnership, a theoretical foundation is required, we link the outcome of the interviews to theoretical categories. The type of interview can be considered as a semi-structured interview (Bryman, 2015).

The method of coding is subject to the researcher's interpretation and therefore offers a debatable outcome (Saldana, 2009). The first step in this coding method was to underline parts of transcribed texts of the stakeholder interviews that possible could be linked to factors influencing the supply chain partnership performances. Subsequently these parts of the text were interpreted by the researcher. The interpreted quotes are then linked to the theoretical codes. Finally, a conclusion will be given about certain characteristics presents in the collaboration between HNS and Alpherium.

Chapter 4

Case study analysis

Information on the case study subject was retrieved through stakeholder interviews and desk research. This chapter elaborates on the subject of the case study and aims to provide a detailed and comprehensive insight into the collaboration between HNS and Alpherium and the processes that take place as a result of that collaboration. The first step is to identify the different stakeholders, their roles within the process and relation with each other. The second step is describing the different planning processes and accompanying information flows. The final step is to depict a schematic view that brings together all material and information flows in the VSM.

4-1 Stakeholder analysis

To provide the reader with an insight of the stakeholders involved in the overall process, both internal and external, a stakeholder analysis will be performed.

We will subdivide the stakeholders based on the operational process and based on the information flows as described in the prior chapter. Considering the material flows the stakeholders directly involved are, on an organizational level, the deep sea terminals and depots, the shipping lines, Alpherium, and the brewery in Zoeterwoude.

- The different **shipping lines** can be seen as the second tier suppliers as they are responsible for the supply of empty containers to Alpherium. However, the shipping lines outsource the transport of empty containers destined to Alpherium to Van Uden Barging. Therefore their main concern is the availability of their containers at the terminal or empty depot.
- At Alpherium the barges are planned in consultation with **Van Uden Barging**. The barges are provided by Van Uden, the planning is made at Alpherium. The pick-up appointments are made with the deep sea terminals and depots.

- **The deep sea terminals and depots** perform the required handlings in order to load and unload the containers from and on to the barges.
- **Alpherium** performs the loading- and unloading handlings at the hinterland. Both the barges as well as the trucks are handled at the inland terminal. Alpherium is responsible for scheduling of barge and truck transport. Alpherium can therefore be seen as the first tier supplier to the brewery.
- **The brewery** at Zoeterwoude can be seen as the "customer" within the scope and focus of this research. The demand for empty containers is created at HNS. The empty containers are required at the brewery in order to be able to cross-dock the brewery's production.

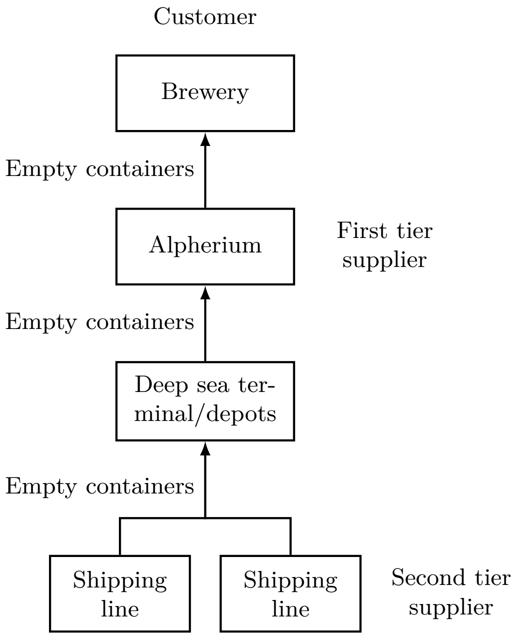

Figure 4-1: Relational diagram stakeholders

Besides material flows, the supply chain includes information flows. The different stakeholders fulfil a function in the flow of information as well. The information flows are required for starting and continuing the flow of material through the supply chain. In order to understand the information flows the process should be considered on a more detailed level, with taking into consideration the different roles of the individual stakeholders as part of the process. For this research the focus lies on the stakeholders involved in the export process and who can directly influence or be influenced by the container availability (CA) or for who monitoring the CA is a main task.

Only those individual stakeholders or departments of HNS that are linked to the process through an information flow are discussed here. All information flows are discussed in detail in Appendix B . Figure 4-2 depicts those information flows between the different stakeholders in a stakeholder map.

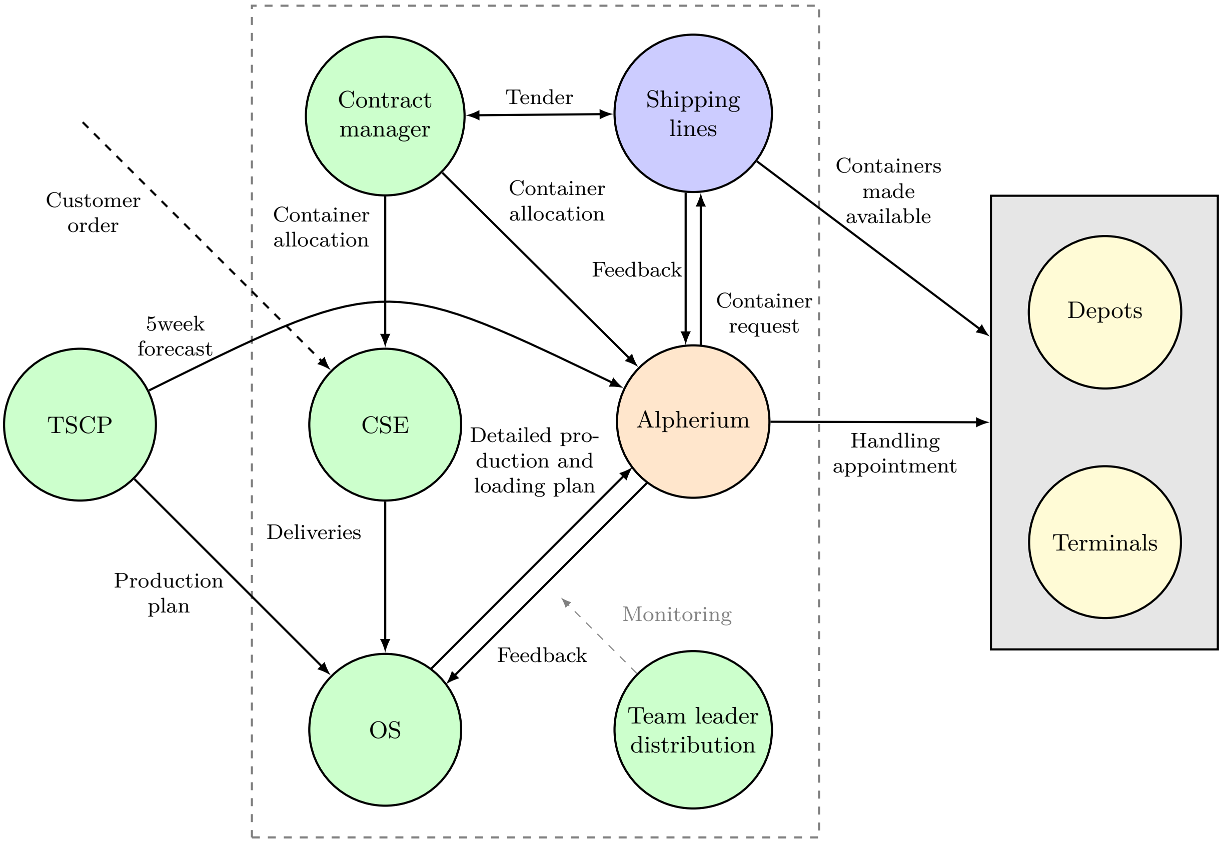

Figure 4-2: Stakeholder map

The logistics department at HNS exists of a number of different sub-departments. The overall department is called Customer Service &Logistics. All stakeholders and sub-departments part of HNS belong to the overarching department CS&L.

HNS: Customer Service & Logistics

Contract manager: The agreements between the contract manager and the shipping lines function as guidelines for the overall processes throughout the entire year. Based on the different tariffs and destinations, the annual demand and production forecasts made at HNS, the contract manager decides on the allocation as part of the *tender* of the coming year. The allocation includes the share per shipping line, considering the number of containers, size, colour and type as well as the division over Zoeterwoude and Den Bosch and the terminals in Antwerp and Rotterdam. This way, when transport is scheduled, it can be scheduled according to the pre-arranged allocations and every shipping line gets their share. These activities mainly take place on a strategic planning level. The allocation among shipping lines, functions as the input for the *safety stock* as determined by Alpherium. Besides the allocation, the contract manager fulfils a monitoring role during the year. She facilitates in organising meetings with a focus on the pre-defined KPI's and makes sure that reporting is done continuously and not only in case of an incident. This way she supports in defining and reaching operational targets and close contact between collaborating partners, i.e. monitoring the process' quality. During the interview, the contract manager stated that she operates from the interests of HNS. However, remaining critical towards the demands from HNS to Alpherium. When demands are unrealistic she can function as a mediator. In the case of an incident or major disruption that cannot be solved by Alpherium, the issue is escalated to the contract manager. In some situations she can get things done by the shipping lines that Alpherium cannot, due to the position of HNS as an important customer.

The contract manager formulated the goal related to the container availability as reaching the CA targets and preventing rescheduling of production and loading at HNS. Furthermore she focuses on limiting overall costs, durability of the process and partnerships and to do this from a more end-to-end perspective.

Tactical Supply Chain Planning (TSCP): TSCP plans the production for the Heineken breweries with a maximum time horizon of 13 weeks ahead. TSCP determines how much beer will be produced, when and on which packaging line. In addition to this they manage packaging material and its stock sizes per different product type. TSCP is not directly linked to the process of container availability as they operate on a more tactical level. They do however fulfil an important role as they provide Alpherium with a *5-week forecast* of container demand. Alpherium uses this forecast to decide on the barge capacity for the coming weeks, as they cannot down- or up-scale the barge capacity on the short term.

Customer Service Export (CSE): customer service and export (CSE) can be seen as the link between Heineken and the customer within this specific export process. After receiving customer orders, CSE uses the information of these orders to create *a delivery*. For a delivery, they book a shipment for a specific order, in an assigned container, depending on the annual allocation, to the requested destination. If the deliveries are complete and contain a closing time, arrival time, boat name, destination and booking number, they will be send to Operational Scheduling (OS). This takes place simultaneously with TSCP's production plan. When both are finished, the deliveries and production plan are compared to check if they overlap so no shortages or surpluses will arise. CSE therefore 'creates' the container demand based on the customers' demand. CSE is directly linked to the export of loaded containers and are therefore not focusing on container availability but on delivering the loaded containers on time at the deep sea terminals. At CSE they are mainly concerned with first order right management, basically meaning that no mistakes are made from the moment the customer makes an order, till their deliveries are send to operational scheduling department (OS). They also focus on meeting the assigned allocations per shipping line, in order to allow the shipping lines their share of the overall export process.

Operational Scheduling (OS): OS operates on an operational level and has a relative short-term view of around a week and a half. Based on the production planning from TSCP and the deliveries from CSE, OS makes a brewery planning or production plan. With the brewery planning as input, OS creates *a detailed production and loading plan.* The loading plan includes information on when production is expected to be loaded, in what container it should be loaded, how many containers are requested and when loaded containers should be at the deep sea terminal for its assigned shipment. This detailed loading plan entails the most recent insights from the packaging schedule and takes into account delays or activities that were ahead of schedule and is therefore updated every day. The production and loading plan forms the input for most operational activities at Alpherium.

Considering the export process through Alpherium, OS focuses on achieving a high cross-docking percentage and preventing distortions in shared information towards Alpherium.

Team leader distribution (warehouse): In principal the team leader distribution oversees the activities performed at the warehouse. At the warehouse the packaged production is set up and made ready for cross-docking. If there is no empty container available for production, production has to be stored at the assigned storage space in the warehouse. As stated earlier storage capacity is very limited. The team leader therefore takes place in a daily consultation between Alpherium and OS and wants to know beforehand if they expect any problems considering the CA.

Market business partners (MBP): MBP can be seen as a link between the planning departments at HNS and the market. They provide the planning departments with sales and forecasts, i.e. information about the market. They possess information about the current status of different market stocks. MPB are not directly related to the container availability and mainly focus on the export of loaded containers to the overseas markets.

Alpherium

In general: Alpherium functions as a logistic service provider for different hinterland shippers, but mainly for Heineken. They manage a part of the transport and planning for the brewery in Zoeterwoude. Transport of containers to and from the brewery by truck and transport by barge from and to the deep sea terminals in Antwerp and Rotterdam. The terminal is used for the storage and transshipment of empty and loaded containers. For these activities Alpherium arranges the required trucks, barges, employees and other resources. Their main goal is to make sure that all loaded containers are shipped to the deep sea terminal on time and that the container availability is on target, ensuring that the production processes can continue. In general they focus on durability and keeping road transport to a minimum. Naturally they try to plan their transport and storage capacity in a most optimal way.

The terminal manager: The terminal manager is responsible for the daily operations and makes sure that the working conditions for his employees are acceptable and that the materials and machines they work with are in good condition. He functions as someone the others can talk to if they encounter issues or dilemmas they cannot solve on their own. On a longer term, the terminal manager focuses on better streamlining the overall process and sets certain guidelines, like determining the safety stock at the beginning of the year.

The barge planner: The planner has a more operational role. The main task is planning the destinations of the different barges, to what terminals they transport containers and what empty containers to bring back and from where. The barge planner keeps in close contact with the planners of the collaborating organizations. Contact with the shipping lines is mostly about empty equipment. Considering HNS, he has most frequent contact with OS about whether or not the detailed load planning is attainable for Alpherium. Every day, they update each other on the progress of the production and load plan and the container availability at the terminal. In case of exceptional or incidental issues, he consults with the terminal manager. It is important for the barge planner that the detailed loading plan he receives on Wednesday is complete to a large extent. Late modifications to this plan can make it difficult for the planner to fit his barge planning to HNS' loading plan and supply the required containers.

Alpherium is part of the mother company Van Uden. The terminal manager at Alpherium answers to the manager logistics at Van Uden. Van Uden is responsible for making appointments at terminals and depots to load and unload containers.

Van Uden

Van Uden in general: Van Uden rents the barges and charges Alpherium for their use based on the transported Twenty Foot Equivalent Units (TEU's). The barge planners at Van Uden help the barge planner at Alpherium, and make the appointments with the terminals. Van Uden focuses on having a happy customer at the highest possible efficiency and lowest costs.

Logistic manager Van Uden: The logistic manager at Van Uden regulates the actions done by Alpherium. He checks if capacity is scheduled fitting to demand and focuses mainly on financial aspects of the overall picture. He has a monitoring function considering the processes performed at Alpherium and overseas communication between Alpherium and the terminals. During or after a disruption and when extra costs have to be made, he discusses the possibilities with the terminal manager. Like the contract manager he fulfils a more monitoring role and does not actively participate in the operational process

External stakeholders

For the export processes to take place, HNS and Alpherium collaborate with different shipping lines. The different shipping lines, can vary in size and have different ways of performing the required activities. However in general they fulfil the same role within the transport chain.

Shipping lines: Overall in the report, we refer to shipping lines. However, it actually are agencies of the shipping line and not the shipping line itself. These agencies are accountable to the shipping line's head office, often located in the country of origin. They form a link between client and head office. In general all those involved in the supply chain speak of shipping lines when speaking of the agencies, which was adopted for this research.

Within the export processes as part of the export flow towards the overseas markets, the shipping lines play two major roles. The first role is where they provide transport from the deep sea terminals in Rotterdam and Antwerp to the assigned destinations. The second, and for the scope of this research, more important role is that they provide the containers to Heineken. As stated earlier, at the beginning of the year the shipping lines negotiate with the contract manager resulting in the annual allocation as part of the *tender*. A share of the transported export volume is given to each shipping line. The shipping line is responsible for the transport and availability of the empty container to the Heineken brewery. As stated the hinterland transport to Alpherium and the road transport to the brewery are outsourced. The shipping line remains responsible for the availability of empty containers at the assigned deep sea depots, leaving Alpherium responsible for the arrangement of transport. The deliveries made at CSE give a first insight to the shipping line on how many containers should be available and when. Based on the barge planning made by Alpherium, the shipping line makes sure the containers are made available at an assigned depot for Alpherium to pick them up. In some cases containers cannot be made available on time by the shipping line due to material shortage caused by e.g. a delayed export trip for another customer. They provide Alpherium with feedback on the barge planning stating the possibilities and impossibilities.

The shipping lines see their role as fulfilled when the requested equipment is available and they hear nothing from Heineken. In general it is important to a shipping line that containers are continuously moving. In their collaboration with Heineken, they are relatively flexible with the assigned free time for demurrage of 14 days.

As described, agreements are made between Heineken, Alpherium and the shipping lines. However, the terminals and empty depots play a very relevant role in the process as well.

Deep sea terminals and depots: Within the process, terminals and depots make few demands and are linked to the process through the shipping lines. They have no contractual agreements with HNS or Alpherium. The terminals play a role in the transshipment from barge to deep sea vessel and the handling of barges for loading empty containers. The shipping lines look after the container flows and the terminals or depots provide space, labour and time to handle the containers. The shipping line in this process, is the terminals' customer.

Some terminals or depots are open 24/7 while others have restricted opening times. This needs to be kept in mind, when Alpherium plans the barge trips. The terminals and depots aim to perform all handlings according to the earlier made appointments, but deep sea vessels are given priority over barges, possibly resulting in delays for the barges. In a way the deep sea terminals and depots can be seen as a restriction to the overall process, forcing the barge planner to plan around these restrictions.

In conclusion, different stakeholders are involved with the CA on a strategical, tactical and operational level. Stakeholders are considered critical when they can directly influence or be influenced by the container availability. *The critical stakeholders* in this process are:

Contract manager: The contract manager is the person where the operational stakeholders go to in case of a severe disruption and escalation is required because of the relation between contract manager and shipping lines. The contract manager is also the go-to person when the collaboration between Alpherium and the shipping lines is going difficult. The logistic manager at Van Uden is not assigned as critical since he has no contact with the planning departments at HNS.

OS: OS translates the production plan made by TSCP and the deliveries made by CSE into a detailed production and loading plan. Since they are the link between HNS and Alpherium they are seen as the most critical planning department at Heineken. Another reason for them to be a critical stakeholder is their involvement in the cross-dock process. Together with Alpherium they plan the loading moments in such a way that cross-docking is possible.

Terminal manager Alpherium: The terminal manager at Alpherium is seen as a critical stakeholder as he oversees all activities performed at Alpherium. He is also decides, in consultation with the barge planner, the barge capacity for the coming week. He is responsible for all decisions made at Alpherium that can influence the CA, e.g. the safety stock.

Barge planner Alpherium: The barge planner is a critical stakeholder because he creates the planning that directly influences the CA for the coming week. He is in close contact with OS and together they perform planning activities to ensure the cross-dock moment.

Shipping lines: The shipping lines are seen as a critical stakeholder as they are the supplier of the required empty containers. If the shipping lines perform poorly the CA will definitely suffer from it, as there are not enough available empty containers.

Although the terminals play an important part in creating the barge planning and therefore the availability of empty containers, they are not considered a critical stakeholder. But, as discussed earlier, as an external restriction.

Now that the critical stakeholders are determined and described, the planning processes that take place between different stakeholders, will be described in the next paragraph.

4-2 Planning processes

This paragraph aims at providing the reader with an insight into the planning processes and their difficulties. The planning for the shuttle service is excluded from the scope, as well as the warehouse activities because they do not influence the CA as defined in this project.

In order to understand the planning processes and the accompanying challenges, it is important to understand the different planning processes over time. Figure 4-3 shows the planning processes that take place between HNS and Alpherium in order to guarantee the continuity of the process. Below the different process flows are explained. The planning processes take place on three different planning levels.

- Strategical: Long term planning aimed to identify "optimal timing, location and extent of additional investments in processing networks over a relatively long time horizon ranging from 5 to 10 years" affecting long-term performances of the system .
- Tactical: Exist of features of both strategic and operational planning levels. And can be aimed at stock levels and key resource limitations.
- Operational: Characterized by a very short time horizon. In which exact sequencing of manufacturing tasks are addressed while "accounting for the various resource and timing constraints" (Gupta & Maranas, 2003).

Figure 4-3 shows how every year new tender agreements are made between the contract manager and the allocated shipping lines, which influence how CSE makes the deliveries. On a tactical level, the 5-week forecast gets updated by TSCP every week. The terminal manager monitors this, in order to pro-actively adapt the barge capacity to peeks and lows in production and thus transport demand.

The production and loading plan made by OS is most extensive on Wednesday, containing a forecast of 1.5 weeks and is updated every day. An important aspect of the detailed production and loading plan is that it is not continuous and is renewed every Wednesday with the input of CSE and TSCP.

Every Wednesday the barge planner at Alpherium (ABP) creates a new barge planning based on the first version of the detailed and extensive loading plan created at OS. Thursday they receive a second version of the detailed production and loading plan and if necessary, they can adapt their barge planning to it. In some cases, some final adaptations to the extensive detailed loading plan are made on Friday, e.g. when deliveries do not match the production plan. However, usually OS aims at providing the final extensive detailed planning on Thursday. Throughout the week adaptations can be made as the result of the events within the brewery. The shipping lines are required to provide their feedback on the barge planning made on Wednesday, before Thursday afternoon. This way they have time to attain information on whether or not Alpherium can pick up the containers at the requested moment and deep sea terminal or depot.

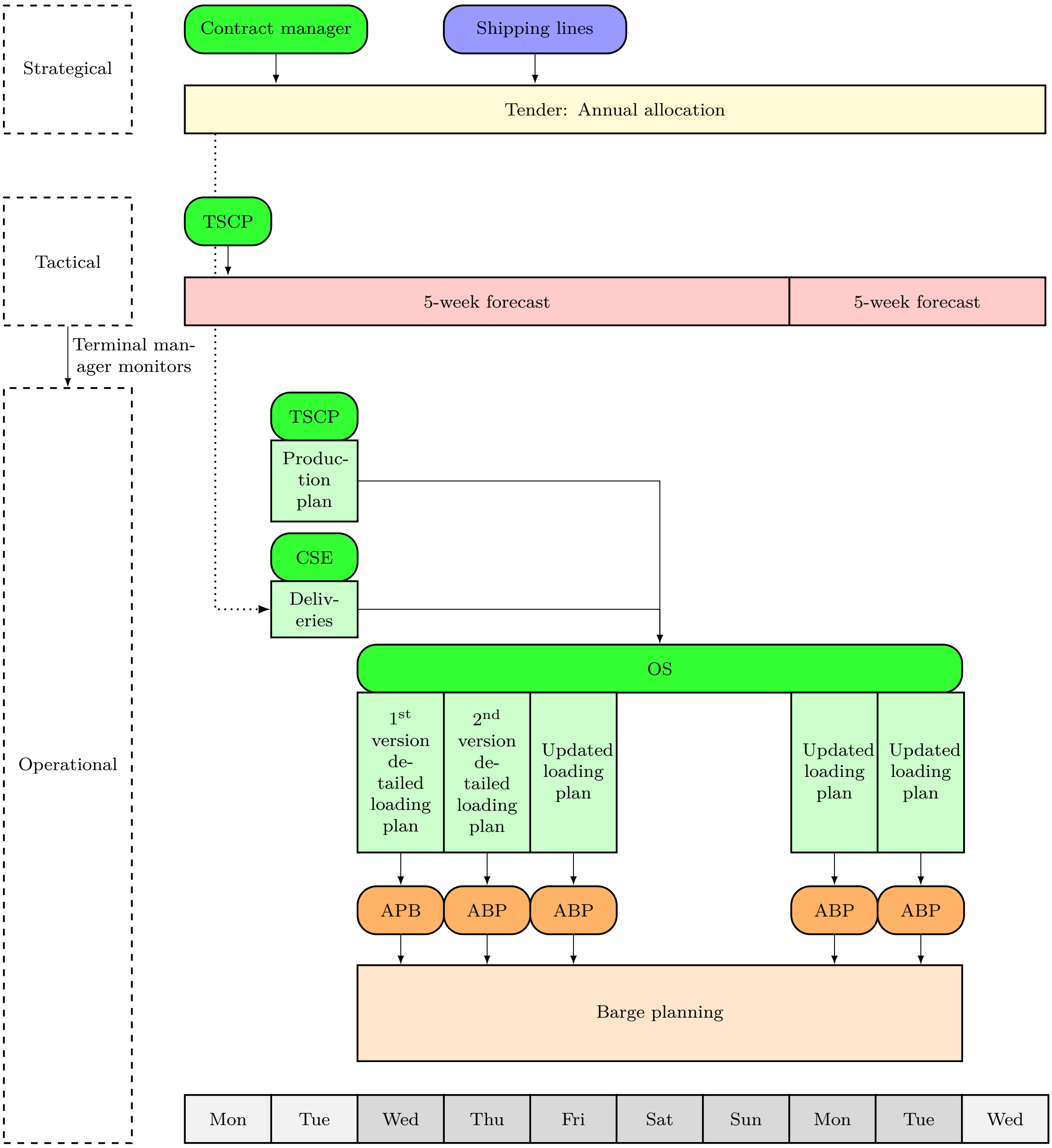

Figure 4-3: Planning processes on three planning levels

The barge planning is considered as the most crucial step of the overall processes. The barge planning influences the supply of empty containers and is therefore directly linked to the CA. In a way the CA is determined on the compatibility of the barge planning and the loading plan, where the barge planning is based upon the loading plan, which is depicted in Figure 4-4.

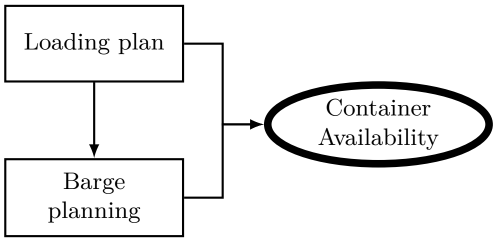

Figure 4-4: CA as output loading plan and barge planning

Figure 4-5 shows the barge planning in more detail. The barge planning includes the detailed production and loading plan from Wednesday up onto the next Sunday which is shown by the green blocks. Since every Wednesday a new detailed production and loading plan is sent, there arises an overlap in part of the planning of the following week, depicted by the coloured shadows in Figure 4-5. Thus, in practice the barge planning is made for the Monday up to and including Sunday after that. When necessary adaptations can be made to the overlapping days, Thursday up to and including the first Sunday.

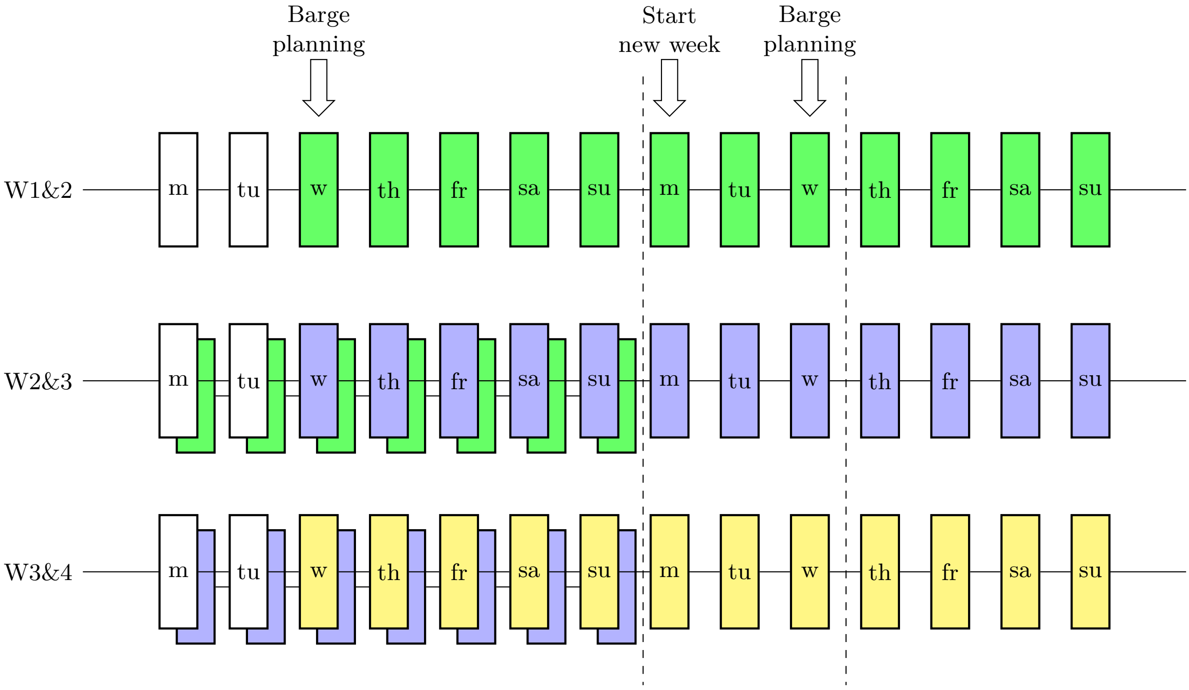

Figure 4-5: Barge planning in detail

In order to monitor the progress of the planning. Agreements were made between Alpherium and HNS to make sure the required information is shared through fixed steps. These steps are described in Table 4-1.

Besides the monitor processes described above, Alpherium is kept informed about the barges

Table 4-1: Communication processes

Communication processes in order to monitor performance		
When?	**Name**	**Input**
Every day	“Schakeloverleg”	Discuss the container availability for the coming days, foreseen problems and possible actions.
Every week (Thursday)	Operational meeting	Discuss the planning and possible foreseen issues and decide on a final detailed loading plan and possible changes in the packaging schedule. The input for this meeting is the feedback from Alpherium on the detailed loading plan.
Every two weeks	Two weekly meeting	Discuss the performances considering the shuttle service
Every two weeks	Two weekly meeting	Discuss the performances considering the shuttle service and CA performances of the past two weeks, as well as ongoing projects and outcomes.
Every month	Tactical meeting	Discuss the past months’ performances, as well as finances on a management level.

whereabouts through emails send by the barge planners at Van Uden. Every week day, the barge planners at Van Uden receive an update of from the shipper and send the information to Alpherium and the logistic planner at Van Uden. These emails are called the STAVAZA, which stands for current state of affairs (stand van zaken).

4-3 Value Stream Map

Figure 4-6 shows a simplified version of the VSM. The extended version can be found including a legend in Appendix B. It can be seen that the process roughly exists of two main sub-processes: the export process of loaded containers and the import process of empty containers. The import process starts at the port of Rotterdam or Antwerp and ends when the container arrives at the brewery in Zoeterwoude. From there, the export process starts until the arrival of the container at the port of Rotterdam or Antwerp. As discussed in the introduction, the scope does not reach beyond the ports of Antwerp and Rotterdam, so here the process stops. Both sub-process use multi-modal transport, existing of road and inland waterway transport. The subject we follow through the VSM is a container.

The VSM was validated by the barge planner and terminal manager at Alpherium, as well as the loading planner from the operational planning department at Heineken, and the team leader distribution of the brewery.

4-3-1 Import empty containers

The moment a barge arrives at Alpherium from the deep sea terminals and/or depots with empty containers, the barge will be positioned under one of the two cranes, when available. When the barge is correctly positioned, the crane machinist starts with unloading the empty containers from the barge to an empty container stack. The moment Alpherium receives a call from Zoeterwoude, requesting a certain container colour and type, a reach stacker or empty handler will unload the empty container from stack to the truck. The reach stacker and empty handler have a small computer inside, containing information on the container’ locations. When the empty container is loaded onto the truck, the truck drives the container to the brewery of Zoeterwoude. Arrived at the brewery, the truck detaches the empty container and positions it at an assigned dock. The truck then leaves the VSM, as it picks up a loaded container that was ready and returns to Zoeterwoude.

When production is ready, the cross-dock moment can take place and the production is loaded into the empty container. Although the export process is not the focus of this research, it is included in the VSM. In order to understand the logic of the import process it is important to understand the overall process between the deep sea terminals and the brewery in Zoeterwoude.

4-3-2 Export loaded containers

When the container is loaded, a truck located at Heineken that dropped of an empty container, picks up the loaded container and transports the loaded container to Alpherium. Here the loaded container is unloaded from the truck by a reach stacker and loaded onto an assigned stack close to the cranes. Based on the barge planning, the cranes will load the loaded containers from stack onto a barge. When loaded according to plan, the barge will leave Alpherium and transport the containers to the assigned terminals in the port of Antwerp or Rotterdam.

The barge planning and detailed loading planning function as an information input flow for both sub processes. Therefore, we will discuss these in more detail below.

The detailed loading planning, in essential is a collection of information. The information refers to the schedule a container should follow in order to arrive at his destination on the predefined destination. As can be seen from the VSM, the detailed loading plan functions as an input for the barge planning. The barge planning, like the detailed loading planning, consists of a part for both the export and the import sub-processes. An example of a barge planning can be found in Appendix E. The barge planner uses Alpherium as its focal point. The barge planning contains information on what colour and type containers are coming in, from where and when. Considering the loaded containers, the barge planning only contains information on how many containers will be transported to which terminal and at what time they are supposed to be handled. It specifies the container sizes but does not specify the shipping line. This is done when the barge planning is finished, based on the detailed loading planning. The barge planning is made per barge, put together in one document.

Considering the scope and focal point of this research, the emphasis lies on the sub-process of importing empty containers. The import process is directly linked to the container availability as it replenishes the empty container stock.

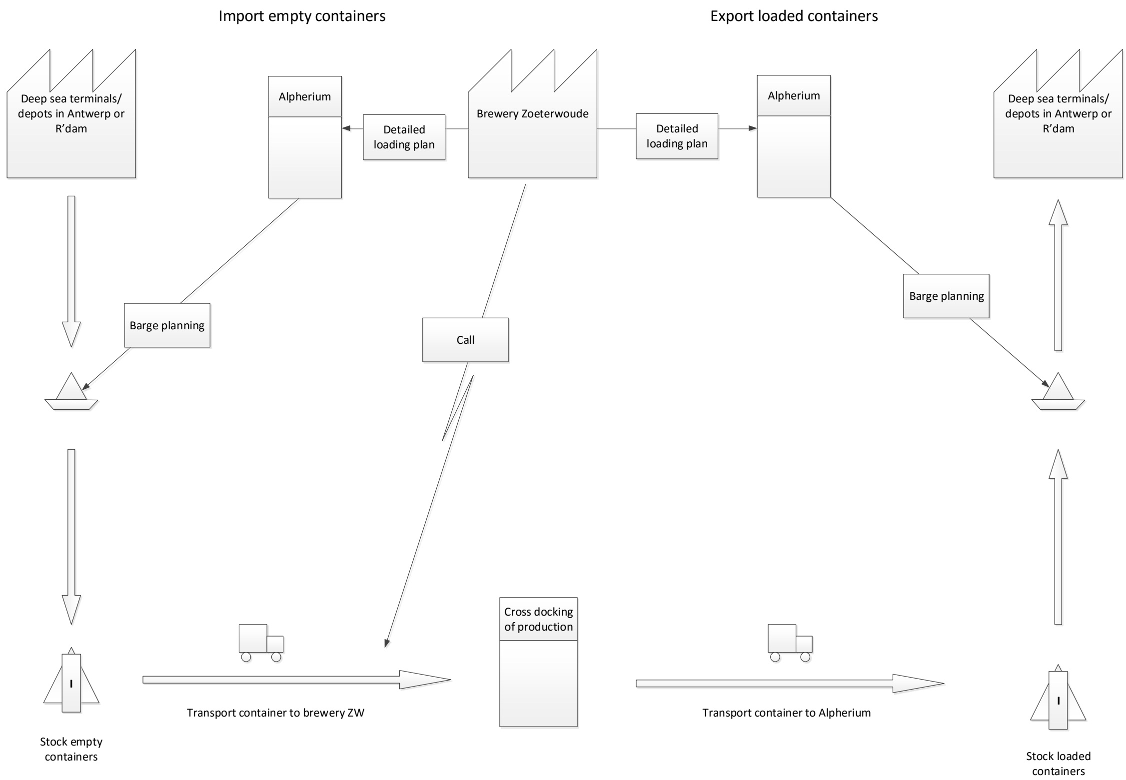

Figure 4-6: VSM simplified

Chapter 4 aims at providing an overview of the case study in which both material and information flows are provided. The dynamics of the overall system, and its corresponding stakeholders are made clear. Information about the case study is required in order to understand what potential and actual disruptions might harm the system, and therefore possible damage the set targets. In the next chapter, these potential disruptions will be identified as supply chain risks and evaluated based on the knowledge retrieved in Chapter 4.

Chapter 5

Supply chain risk and disruption management at an inland terminal

5-1 Supply Chain Risk Management at the inland terminal

As discussed in Chapter 3 the first step of the SCRM-cycle is 'Scope definition and risk identification' (Behdani, 2013). First we need to select the system and define its boundaries as subject.

5-1-1 Selection of system of study and the related critical objective and performance indicators

The selection of system of study for this research concerns the case study on the collaboration between HNS and the inland terminal Alpherium, and therefore just a small part of a total supply chain. Chapter 4 provided an insight into the case study, the related stakeholders and the planning processes. This paragraph aims at setting clear boundaries for the system subject to the integrated framework for managing disruption risks. Most of this has already been done in Chapter 4 , therefore the conclusions are listed here, and finally depicted in Figure 5-1

- The system that is looked into is the import process of empty containers to Alpherium. The material flow scope is limited to the deep sea depots and terminals in the harbour of Rotterdam and Antwerp and the inland terminal Alpherium.
- Considering the scope of the information flows, we take into account the information flows that are send or received by the critical stakeholders. Only those information flows that can be linked to the CA are part of the scope.
- Figure 5-1 shows a map based on the import process as depicted in the VSM in Figure 4-6, that forms the input for the integrated framework for Supply Chain Disruption Risk management.

- Although the shipping lines are not located at the ports, they are considered part of the area as their activities are centred within the deep sea ports of Antwerp and Rotterdam.
- The terminal operators are considered an external party as they do not have agreements with any of our two problem owners; HNS and Alpherium. However as an external party they can form a risk to the overall process and are therefore considered within the system of study as a restricting factor.

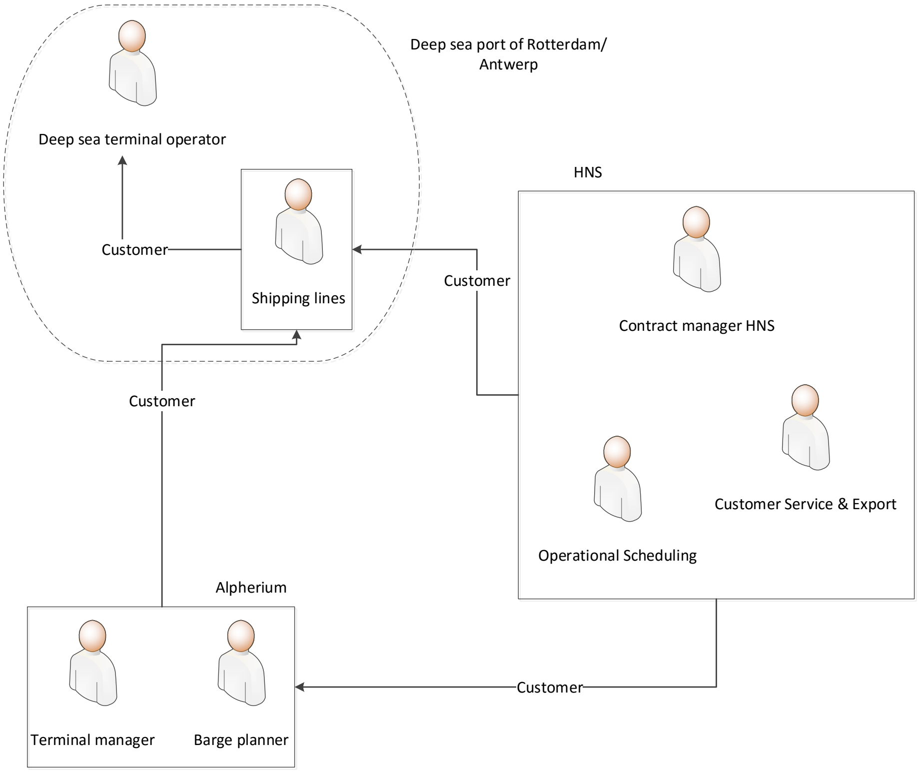

Figure 5-1: System of study

As stated earlier, the availability of empty containers (CA) is critical to cross-dock production at the brewery. The warehouse has limited storage capacity, and storage at the warehouse increases the required handlings and decreases process efficiency. Figure 5-2 shows the order of the objectives. In order to attain a highly efficient operational process, cross-docking of production must take place. The CA is the first objective that can be directly influenced by critical stakeholders. Another reason for the importance of the CA is securing the continuity of the brewing process. Shutting down production is very costly, and has to be prevented at all time.

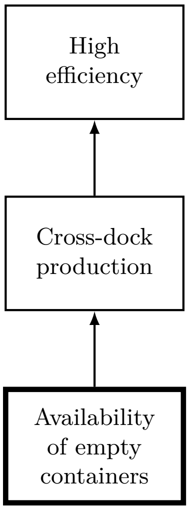

Figure 5-2: Critical objective

In conclusion the availability of empty containers (CA) at Alpherium is the critical objective of the system. As stated in Section 4-2 both the detailed loading planning as the barge planning directly influence the availability of empty containers at Alpherium. If they are overall compatible, the CA would be a 100%. This can only be attained when the planned barge capacity is big enough to transport the requested containers. If compatibility is low, OS has three options:

1 Exchange production to another container

Production has to be loaded into an assigned container. The assigned container depends on colour (the shipping line), size and type (dry, reefer, non-working reefer). In some cases, if for example container type and colour A is not available for production, but the same type of production goes into container colour B which is available, OS could exchange the containers. This way, the production can be cross-docked and operation within the brewery will not suffer any consequences. When container A is available, it can be used for production prior assigned to container B.

2 Reschedule

If the exchange of production is not possible OS will have to reschedule their production and loading plan. E.g. deliberately delay production from Tuesday to Friday and bring production from Friday to Tuesday. This way, the cross-dock moment can still be realised. Ideally this is limited to one of the many production lines, as it minimizes the amount of rescheduling and required adaptations. Rescheduling and adaptations of production lines result in a decrease of the brewery's efficiency.

3 Storing of a small amount of containers

In some cases, the number of containers not available is relatively small. This can lead to OS making the decision of storing the containers in the warehouse. A small number of containers forms no risk to the continuity of the production process, and it leads to only a small amount of extra handlings.

4 Another option would be to hire trucks that can pick up empty containers within a relative short period of time. This is a very costly option and is usually a last resort.

If the barge planning and the loading plan are completely compatible, none of the above would be necessary. Thus in an ideal situation there would be no rescheduling, no storage and no added transport costs. Therefore the amount of rescheduling, unplanned added transport costs and storage of export production can be considered as performance indicators of the CA.

In order to control the CA as a critical objective, a target was set for the performance of the CA. The CA is insufficient when on a daily level the number of empty containers expected to be requested is higher than the number of empty containers in stock at Alpherium. The CA is calculated as a percentage. This percentage represents what part of the requested containers are available at Alpherium. As discussed earlier, the CA is calculated per different type, size and container colour.

Table 5-1 below shows the way the CA is calculated. The target for the CA is 100%. This means that the number of containers stored at the warehouse as a result of an insufficient CA has to be zero.

Table 5-1: Container availability target

CA (target=100%)	The empty containers available at Alpherium as part of the requested containers) / The number of empty containers requested

Added transport costs are registered and discussed during the tactical meetings, but can have several causes. Currently there are no measure methods for the amount of rescheduling. Rescheduling does not only take place as a result of an insufficient container availability it can also have to do with production capacity, delays or production ahead of schedule or packaging material shortages. Therefore, quantifying rescheduling as a result of an insufficient CA is very difficult. Currently the amount of rework for OS is qualitatively rated by themselves. For this research the focus lies on the performance of the critical objective' target, as it is easily quantified and considered as the KPI of the process by both HNS and Alpherium.

Now that the system is clearly scoped and the critical objective and related performance indicators are defined, the supply chain risks have to be identified.

5-1-2 Identifying supply chain risks

Based on the theoretical foundations described in Section 2-2, a schematic overview of the different risk and sources of risk was made. This schematic overview was filled in based on the outcomes of desk research at the case study about disruptions that happened in the past. The outcome is depicted in 5-3. The risks are given a different colour per category of source of risks. The pink blocks show the possible results of these sources of risks and are not part of the categories.The demand and supply uncertainties result in a number of different sources of risks, all included in the same category.

The different risks are discussed in Appendix A, and categorized according to the outcomes of literature research. Based on the risk identification and a qualitative analysis of the results, three main indicators were identified that could harm or secure the critical objective, the CA. These indicators are:

- material availability;
- transport capacity;
- handling capacity.

The material availability directly influences the CA, and is therefore linked the closest to the CA. The other indicators influence the material availability and thus indirectly the CA. All three indicators are subject to (a part of) the identified risks. If one of the tree is impacted, the process cannot be operated optimally. The material availability stands for the availability of empty containers at the deep sea terminals and depots and Alpherium. The transport capacity influences the material availability as it depicts the capacity for empty container supply to Alpherium. The handling capacity stands for the capacity of labour, space and time at both deep sea terminals, depots and Alpherium.

As the main responsible party for securing the CA target, Alpherium is considered the focal organization of the SCRM and SC-disruption management steps. This means that internal risks are risks that threaten Alpherium's own operations. External risks consider risks arising at the deep sea terminals and depots and between the ports and Alpherium, as well as risk arising at HNS.

One of the identified risks that is quite striking is the optimistic barge planning. None of the stakeholders specifically mentioned the uncertainty of the barge planning as a risk. Which could indicate that, apart from the Alpherium stakeholders, the others are not aware of this risk. In order to understand this risk and the threat it poses to the overall process, it is discussed in more detail below. Based on the stakeholder interviews it is assumed that the other risks as depicted in Figure 5-3 were known to (part of) the stakeholders.

Barge planning as a risk

It can be retrieved from the planning process that the barge planning created on Wednesday deals with a number of uncertainties. First of all it is based on the first and not final version of the overall detailed production and loading plan, and that during the week adaptations can be made to the loading plan. Second source of uncertainty is the fact that they have to receive feedback from the shipping lines to let them know if the empty containers can be made available on a specific location and time. However, these are not the only uncertainties the barge planner has to deal with.

A major uncertainty is the one considering the handling appointments at the deep sea terminals and depots or so called quay slots. During the week, slots might be retracted due to delays, congestions or deep sea vessels with a priority over the barge. Certainty about

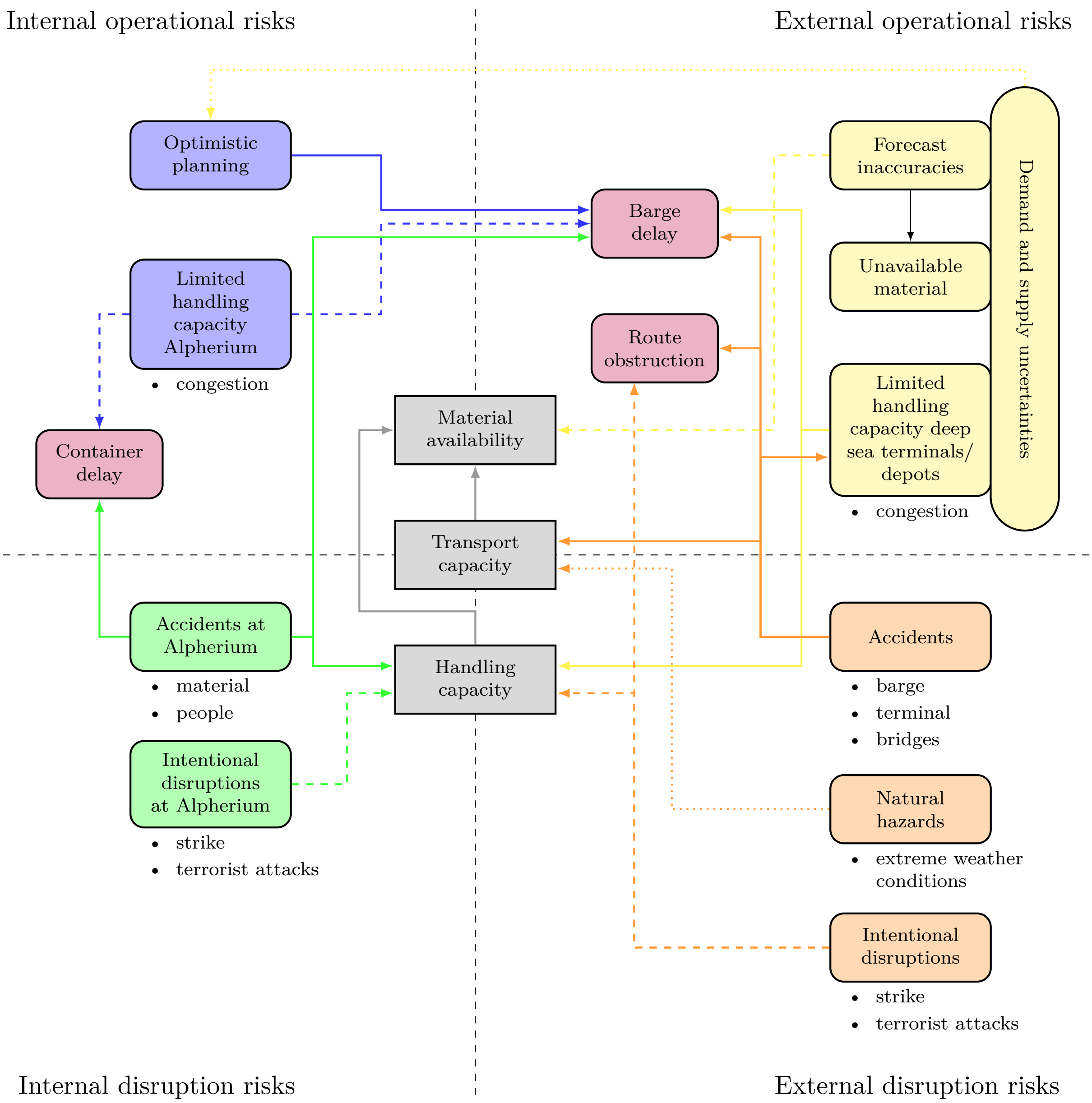

Figure 5-3: Identified supply chain risks and sources

the quay slots can only be given over a period of three days. Every day the confirmation or non-conformation for a slot is added for the third day from that moment. External events can result in the loss of quay slots as well. For some terminals the barge planner has fixed window slots, meaning that a certain moment in the week is reserved for a barge of Alpherium. During the week they can confirm or cancel this slot. If the slot gets cancelled a lot, the fixed time slot will be lifted. Since demand differs per week, fixed window slots are only applicable for a very small part of the planning. The degree of risk as a result of the uncertainties depends on how the barge planning deals with these uncertainties. As discussed in Section 2-3, to deal with uncertainty the planner can choose to create a robust plan for the barges, including a safety time buffer to absorb possible future events that deviate from the anticipated future. In order to find out the degree of risk and how the barge planner takes into account the uncertainty two barge plans were studied in more detail.

The analysis is described in Appendix E. The outcome shows that the planner does not make an overall robust planning for the barges. As can be derived from Appendix E and Section 2-3, this poses a risk to the quality of the planning, as small deviations could result in a relatively high decrease of the quality of the planning which could lead to a less efficient use and loss of the available barge capacity.

The risk container container delay will not be further analysed as this research assumes empty containers arrived at Alpherium as part of the CA. A container present at Alpheruim, but for some reason not available to the brewery, e.g. because of a delay in unloading, no shuttle trucks available, or a misplacement, is therefore not included within the scope of this research.

5-1-3 Quantification of identified supply chain risks

The next step of the SCRM-cycle is to quantify the listed supply chain risks, which entails estimating likelihood and the impact of the different supply chain risks. Unfortunately, there was no quantitative historic data available on disruption impacts to support estimating the impact. Therefore impact was estimated based on one of the three main indicators that could be quantified with the available data; transport capacity. The other two indicators are still considered as to what qualitative impact they could suffer from possible disruptions.

Expected impact on CA

The first indicator we are going to look into is the transport capacity. The expected impact of the identified risks on the transport capacity (barge capacity) was made quantifiable based on the barge planning method.

Transport capacity Transport capacity is vulnerable to a number of different risks, as can be seen in Figure 5-3. These risks could impact the supply of empty containers. TThe supply can suffer from the impact of a disruption trough e.g. not being able to sail or a delay. All of these resulting in a loss of transport capacity in the form of barge capacity.

The impact of a disruption was estimated on a high level, considering the barge planning for that week as the total planned supply capacity. The overall transport capacity of a barge planning depends on four different factors.

1 The number of barges planned for that week.

2 The allocation of trips going to Antwerp and Rotterdam (linked to the different trip times).

3 The planning itself (how many days were the barges planned to sail).

4 The different barge capacities linked to the barges.

Through desk research, the barge trip times and barge capacities were determined. The capacity is expressed in TEU (Twenty feed Equivalent Unit). The trip times are expressed in hours. The trip times include resting time, handling times and sailing time. A trip starts with loading the loaded containers at Alpherium and ends when the barge is back at Alpherium. This is because the containers are considered part of the empty container stock as soon as the barge containing them arrives at Alpherium. Usually the barge planning is made out of five or six barges. The barges Alpherium usually sails with, their barge capacity and the work weeks are depicted in Table 5-2.

Table 5-2: Alpherium barges

Barges	**Capacity empty containers (TEU)**	**Workweek (hours/days)**
Domino	90	24/5
En Avant	90	24/5
Forever	104	24/7
Meta Maria	81	24/5
Muguet	90	24/5
Tormenta	90	24/5

Based on conversations with the terminal manager and barge planner the trip times were originally estimated at 48 hours for a trip to Antwerp and back and 32 hours to Rotterdam and back. In order to calculate the total theoretical maximum supply capacity (TMA) per barge the following formula was created:

$$\begin{aligned} TMA &= \text{Theoretical average number of roundtrips} * \text{Barge capacity} \\ &= \frac{\text{Planned hours}}{\%\text{Rdam} * 32 \text{ hours} + \%\text{Antw} * 48 \text{ hours}} * \text{Barge capacity} \end{aligned}$$

The percentages stand for the part of containers that are picked up from Rotterdam and the part that is picked up at Antwerp. It influences the TMA as it can decrease or increase the average trip time.

$$\text{Total theoretical maximum supply capacity} = \text{TMA}_{\text{Domino}} + \text{TMA}_{\text{EnAvant}} + \text{TMA}_{\text{ForEver}} + \text{TMA}_{\text{Muguet}} + \text{TMA}_{\text{Tormenta}} + \text{TMA}_{\text{Extra}}$$

$\text{TMA}_{\text{Extra}}$ can refer to extra capacity of an added barge or truck capacity.

We use the term theoretical as it does not necessarily represent reality. Inefficient use of barge capacity or an optimistic barge planning can influence the actual planned capacity. E.g. if the barge planner plans two trips with an average trip time of 28 hours, he takes a risk in order to optimize capacity use. And although it is a risk, looking back at the VSM in appendix B, it can be found that the average one-way trip to Rotterdam is estimated at six hours, thus a 28 hour round trip time is not impossible.

The next step after determining the total TMA, is to estimate the effect of a disruption. Therefore, we first refer to the different effects on a qualitative level as seen in Table 5-3. The different effects are linked to an impact on the TMA that is part of the calculation.

Table 5-3: Disruption impacts on transport capacity

Effect on barge capacity	Impact on TMA
Sailing with two instead of three layers	Less barge capacity
No sailing (delay at terminal or natural hazards)	Less sailing hours
An empty trip	Less barge capacity
Longer trip time (delayed or alternative route)	Longer round trip times

Non-sailing results in less sailing hours per barge, resulting in less round trips, which eventually decreases the TMA. Sailing with an empty trip or a layer less, results in a direct decrease of maximum sailing capacity. Incorporating these impacts in the TMA-calculation results to the TMA after a disruption. A more detailed explanation can be found in Appendix F The example used in Appendix F, is based on a week of which the disruptions were very well registered. Currently these disruptions are not yet registered in such a way anywhere in the overall process.

The difference between the TMA and the TMA after a disruption can be considered as the impact of the disruption on the supply capacity of empty containers. This way of determining the expected impact of the identified risks to the transport capacity knows a number of limitations that are discussed below.

- Not all containers on the return journey from the deep sea terminals/depots to Alpherium are in fact empty containers. Some of these containers carry import products for the other customers of Alpherium or import products that will be recycled by Heineken. Usually the loaded import containers are emptied within a day and brought back to Alpherium. Additionally the share of other customers is relatively low. Therefore, and to avoid adding complexity to the research, this is excluded from the research' scope, considering all import containers as empty containers.
- Ideally the empty trips are made with fully loaded barges. Unfortunately, this is not always possible. Based on historical data it was found that the average barge utilization over 2015 is shown in Table 5-4.

  The average barge utilization can be incorporated into calculation of the quantitative impact of disruptions on the transport capacity.
- As stated earlier, the given round trip times were an estimate based on conversations with the barge planner and terminal manager. These times will need to be validated.
- Another issue is that the impact of a disruption can differ per situation. E.g. if a disruption takes place on a Sunday, the impact is different than when it takes place on a Thursday, as only one barge is regularly active on a Sunday.

Table 5-4: Average barge utilization

Barge	Average utilization
DOMINO	90%
En Avant	90%
FOR EVER	94%
Meta Maria	88%
MUGUET	86%
Tormenta	90%

Based upon conversations with the barge planner a number of aspects that influence the impact of a disruption on the CA were determined.

- The duration (which is incorporated in the TMA-calculation).
- The moment of disruption (what day, is there a lot of room for rescheduling, is it a Sunday so only one barge is affected etc.).
- The follow-up appointment of the disrupted barge(s). If it is shortly after, or not, whether it is at a day terminal or not etc. (this can be linked the robustness of the planning).
- Alpherium usually sails with extra capacity, thus the amount of extra capacity influences the impact on the CA as well (extra capacity is a form of risk treatment which will be discussed in more detail in Section 8.

In order to deal with these aspects, the estimation of a disruption impact could incorporate different scenarios, that could either amplify or decrease the effect of a disruption on the CA. How the impact on the CA is influenced is discussed in detail in Appendix F. The outcome is depicted in Table 5-5. A negative scenario indicates a higher impact on both the CA and the transport capacity. A positive scenario could diminish part of the disruption impact. Table 5-5 can be used as an indicator to determine the overall scenario as predominantly negative, positive or average.

Table 5-5: Disruption impact influencers

Aspects	Negative scenario	Average scenario	Positive scenario
Day of the week (CA)	Thursday/Friday	Monday/Tuesday	Saturday/Sunday
Day/night (less sailing hours)			Night
Follow up appointment (delay)	Antwerp/no safety time in planning	Average safety time in planning	Long safety time in planning
Extra capacity (CA)	None	Average	High

Handling capacity The impact of the different identified risks on the handling capacity is harder to estimate as the impact on the transport capacity in relation to the CA.

A limitation in handling capacity at the deep sea terminals or depots can have several effects. A limitation in terminal and depot handling capacity can come in the form of a congestion or can be the result of an accident or an intentional disruption e.g. a labour strike. The terminal can be seen as a supplier to Alpherium, as it supplies Alpherium with handlings and labour in order to create a supply of empty containers to the inland terminal.

The impact of a disruption at an inland terminal on the CA is difficult to determine quantitatively as it impacts the CA mainly through the availability of empty containers. It also depends on which terminal is limited in its handling capacity and how many containers were supposed to be picked up at that terminal. If a deep sea terminal is for any reason not available for quay slots, the assigned empty containers cannot be picked up and are therefore not available to HNS. If this is the case a limitation in handling capacity directly decreases the CA. Another way the impact of limited handling capacity can harm the CA is when it results in a barge delay of which impact is discussed above. In general limited handling capacity at the deep sea terminals and depots results in higher levels of supplier uncertainty, negatively affecting the overall process.

A limitation in handling capacity at Alpherium could result in containers not being unloaded from the barge in time and thus will not arrive at the brewery in time for cross-docking. It could also result in a delay of the barge in total. However, as stated earlier, since containers are considered part of the container stock as soon as they arrive at Alpherium, this is outside the scope of this research.

Material availability The material availability is directly linked to the CA. Any impact of a disruption can be calculated in number of containers. A unavailable container can be directly incorporated within the calculation for the CA in general. If an empty container is not available at the port in Rotterdam or Antwerp it won't be available on time at Alpherium. Material availability can be the source of a disruption but is always the effect of a disruption, considering the critical objective.

Likelihood of identified risks

In order to estimate the likelihood of the different identified supply chain risks we used desk research and the trigger file used by Alpherium and OS. This is a file that can register disruptions that are expected to cause a problem for the CA. It includes information on what type of disruption and how many containers of a specific type and colour it has affected.

Trigger file The trigger file is filled in on a weekly basis and a daily basis. The weekly registration happens prior to the operational meeting between OS and Alpherium. This is a registration of prior known impossibilities for meeting the loading moment. The daily registration takes place during the week to identify issues that turn up that week. Unfortunately, the weekly registration has not been kept up to date continuously throughout 2015, we therefore focus on daily registration. The year 2015 is assumed to be representable for the future, as there is no expectation of major adaptations to the supply chain design or supply chain planning processes. Table G-1 in Appendix G shows the total of all registered triggers in 2015 on a daily basis. This will help us determine the likelihood of the identified potential risks.

It is important to state that all disruptions were registered before taking any recovering actions. Therefore, the disruptions registered might eventually have not affected the CA due to precautionary measures as a reaction to the registration of the expected disruptions.

The most common registered disruption in 2015 was the unavailability of material, registered as ‘shipping line has no containers’. This disruption was registered for approximately 108 containers over 2015. This number was already influenced by current mitigating actions. Without these mitigating actions, the number is expected to be higher. How high is difficult to say, as it depends on many different factors.

The second most common registered disruption in 2015 was ‘new delivery Heineken’ which stands for a delivery that was added to the detailed loading plan, resulting in a new loading moment Alpherium was not prepared for. This trigger can be linked to information flow risks like demand uncertainties and forecast inaccuracies which are the result of the planning process as operated by HNS. The number of containers not available due to this disruption was 100. Here the same accounts as the previous disruption, current mitigating actions can in some cases accommodate such disruptions, preventing them from harming the critical objectives.

The disruption ‘depot does not have time’ was registered for 91 containers in 2015. Depot does not have time is directly linked to limited handling capacity at the deep sea terminals and depots as it means that the depot had no available quay slots. Whether it was the result of a congestion, accident or another disruption is not known.

Other commonly registered disruptions are ‘planning Heineken more than 48 hours ahead’ where a loading moment is planned 48 hours sooner that first anticipated. This can be linked to demand uncertainties resulting in forecast accuracies. This trigger was registered for 49 containers. ‘Delayed barge’ was registered for 48 times. ‘Priority containers have priority’ was registered as a disruption for 43 containers and is considered an effect of an earlier disruption and can therefore not be traced back directly to any of the identified risks as discussed in Section 5-1-2. ‘DHL free-time’ was registered for 36 containers and is considered as supplier uncertainty: material unavailability.

Because of the difficulty of determining the quantitative likelihood of disruptions without the mitigation actions present, we will determine likelihood as a relative number. The three most common disruptions as registered in the trigger file cause approximately 50 % of all disruptions. Together with the other triggers described above they form 80% of the registered disruptions. Of the resulting 20%, 15% is caused by ‘shipping lines do not provide feedback (on time)’ caused by planning with supplier uncertainty, ‘Handling capacity Alpherium’, ‘unknown’, ‘delay depot/terminal’ linked to limited terminal handling capacity and ‘weather’ which is linked to natural hazards. The other registered disruptions cause the remainder 5% of triggers. This information is depicted in Table G-1, Appendix G.

Figure 5-4 shows the likelihoods of the risks relative to each other as the outcome of the trigger file, linked to the risks as described in Figure 5-3. It can be seen that the most common causes are limited handling capacity at deep sea terminals and depots, material unavailability and forecast inaccuracies.

We have not seen triggers related to strikes and route obstructions. Other identified risks like optimistic barge planning risks and intentional disruptions could not be found in the trigger file either. Considering optimistic planning risks, the lack of triggers is easily explained as the

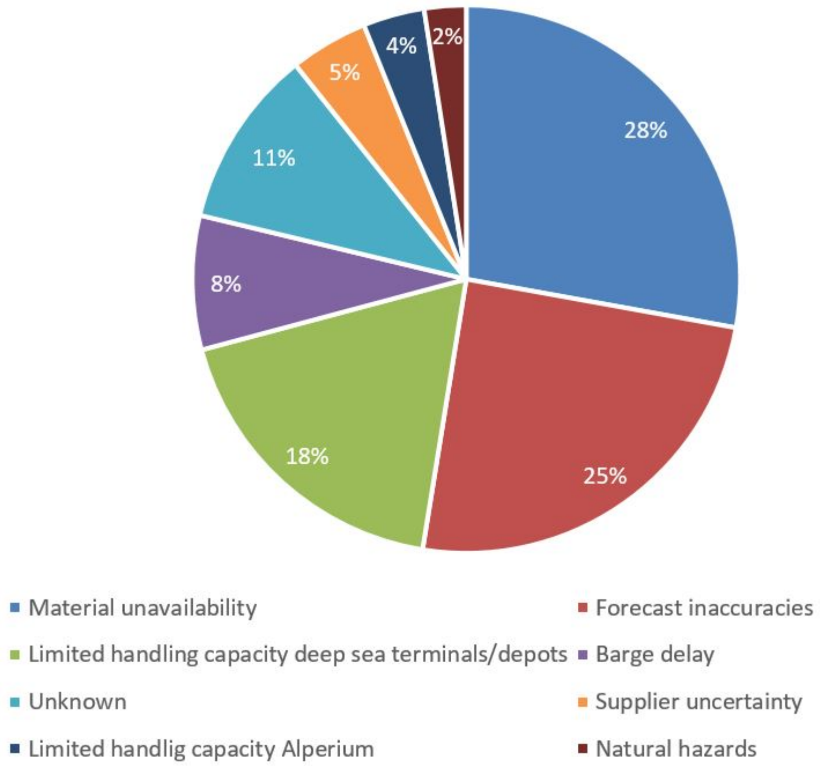

Figure 5-4: Relative likelihoods of risks

optimistic planning is a 'hidden' risk because it results in disruptions that could be caused by other risks as well. E.g. an optimistic planning can result in a delayed barge, which in the trigger file would be registered as a delayed barge. So the likelihood is expressed through the likelihood of those risks directly related to the CA. The likelihood is considered high as the risks reoccurs every week when a new barge planning is made.

The trigger file registers disruptions based on how they affect the CA, root causes of a disruptions can therefore deviate from the registered causes, e.g. route obstructions and/or intentional disruptions.

Likelihood of route obstructions and intentional disruptions The likelihood of route obstructions as a result of accidents and intentional disruptions like strikes or planned maintenance are attained through desk research at HNS and Alpherium. Based on the STAVAZA-emails, and based on conversations with the terminal manager and barge planner at Alpherium.

Considering the risk of barge accidents, in discussion with the terminal manager and the barge planner, the estimated likelihood was 10 issues per year over all barges sailing for Alpherium. Within these 10 issues, approximately one issue would be related to a collision, three issues related to an engine failure and six issues with the barge screw and items getting stuck in it. Barge incidents seem not to be incorporated in the trigger file. It is assumed that barge incidents lead to barge delays or the elimination of the barge from the barge planning what could lead to a limited handling capacity at Alpherium.

Route obstructions can be the result of an accident or planned maintenance. Ideally the barge planner can take planned maintenance into account when he is making the barge planning. Therefore, we focus on route obstructions as the result of an accident. In general route obstruction is caused by incidents with a bridge. Based on comments registered in the trigger file a bridge defect caused barge delays twice in 2015. The likelihood of route obstructions is included in the trigger file in the form of a barge delay.

Intentional disruptions are divided into terrorist attacks and deliberately obstruction of labour i.e. strikes. As stated earlier, a terrorist attack is considered a so-called black swan risk, and likelihood is considered extremely low. In the history of the port of Rotterdam and Antwerp, historic data on a terrorist attack could not be found. Likelihood of a strike is low but can be estimated based on historical data. In January 2016 the Port of Rotterdam was the scene of one of the biggest strikes seen in over ten years. The last strike of employees of the Port of Rotterdam dates back to 2003, when the employees protested against the liberalisation of the port labour (ANP, 2016). Terminal-specific strikes are more common. These terminal-specific strikes are often so-called wildcat strikes as they are not supported by the unions. The likelihood of port-wide strikes is estimated at once every ten years. Terminal-specific or wildcat strikes have an estimated likelihood of once every two years, based upon conversations with the contract manager. The likelihood of these disruptions are not influenced through current mitigating actions.

Evaluation of risk levels

To conclude the previous paragraphs, we determine the different risk levels per identified risk. The risk levels are determined based on the combination of likelihood and impact of the identified disruptions.

The highest likelihood can be paired to supply uncertainties resulting in unavailable material, and forecast inaccuracies resulting in unavailable material as well. Both are considered as external operational risks, and can therefore not be internally fixed. The same accounts for limited handling capacity at deep sea terminals/depots. The impact depends on the amount of unavailable empty containers. Another common disruption is a delay of a barge, which can be the result of multiple other risks, like limited terminal handling capacity (high likelihood), route obstruction (low likelihood) or an optimistic planning (high likelihood). To provide an overview of the different risk levels we depict all risks in a risk matrix in the form of a so-called chance-effect matrix. Table 5-6 provides an overview of the identified risks. The numbers are attached can be found in the risk matrix depicted in Figure 5-5. The different scenarios are part of y-axis, as they could influence the impact of the different risks.

The increase of impact associated with the durance of the disruption only accounts for those disruptions that can be linked to a duration, e.g. a strike or a route obstruction.

Table 5-6: Risk level legenda

External Risks	No.	Internal risks	No.
Supplier uncertainty		Optimistic planning	
Unavailable container	1a	*Barge delay*	7
Low standard container	1b		
Forecast inaccuracies		Limited handling capacity	
Container unavailable	2	*Barge delay*	8
Limited terminal handlings		Accidents at Alpherium	9
Unavailable containers	3a		
Barge delay	3b		
Natural hazards		Intentional disruptions at Alpherium	10
Extreme weather conditions	4		
Accidents			
Route obstruction	5a		
Barge	5b		
Terminal	5c		
Intentional disruptions			
Strike	6a		
Terrorist attack	6b		

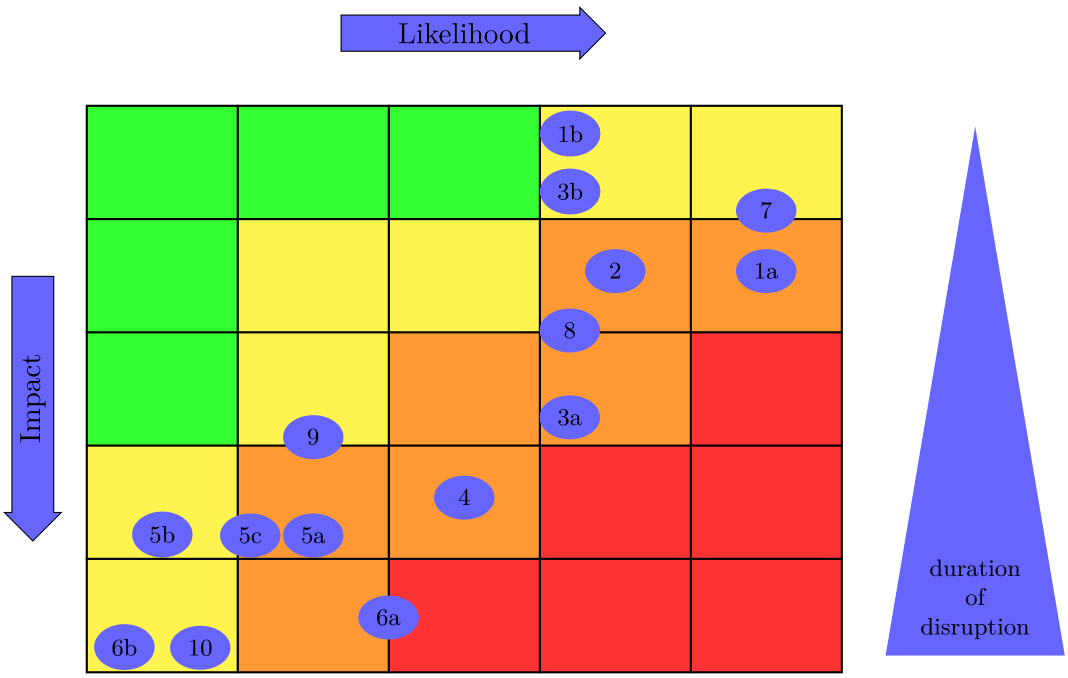

Figure 5-5: Risk levels scheme

5-1-4 Treatment and monitoring

A way of dealing with supplier and demand uncertainty that can result in the unavailability of containers is a buffer stock (Spekman & Davis, 2004). A buffer stuck or safety stock is a traditional way of dealing with supplier uncertainty and forecast inaccuracies (J. V. Blackhurst, Scheibe, & Johnson, 2008). A safety stock can absorb the expected effects of multiple risks, and although it is in contrast with the Just-In-Time principle, it can decrease a supply chain's vulnerability to a great extent.

J. Blackhurst et al. (2005) discuss the use of safety lead times as another way of absorbing disruption risk effects. Both of these mitigation actions have been implemented in the form of two agreements made between HNS and Alpherium.

1 The required containers should be at the inland terminal Alpherium *at least 48 hours before the planned loading* at the brewery in Zoeterwoude.

2 Alpherium should maintain a *suitable safety stock of empty containers*. In order to this, they need to be in close contact with the shipping line. The size of the safety stock will be determined based on the annual volume commitments between Heineken and the shipping parties (HNS & Alpherium, 2012).

Forecast inaccuracies are mainly found in the moment of loading, considering the detailed loading plan. High deviations in container numbers usually do not occur as the detailed loading plan is determined upon the planned deliveries. Therefore, both mitigating actions focus on the forecast inaccuracy of planned loading moments. They are described in detail below.

Safety lead times and safety stock

The CA is calculated with three different safety periods and on the day the required containers are expected to be loaded, resulting in the following formulas. The 't' in the formulas represents the day, where the requested containers are planned to be loaded at the brewery. Where CA t-3 has a safety period of three days, CA t-2 of two days etc.

Table 5-7: CA with different safety periods

CA t-3 (kpi=90%)	The empty container stock at Alpherium as part of the requested containersday(t-3) / The number of empty containers requestedday(t-3)
CA t-2	The empty container stock at Alpherium as part of the requested containersday(t-2)/ The number of empty containers requestedday(t-2)
CA t-1	The empty container stock at Alpherium as part of the requested containersday(t-1) / The number of empty containers requestedday(t-1)
CA t-0 (kpi=100%)	The empty container stock at Alpherium as part of the requested containersday(t) / The number of empty containers requestedday(t)

Targets are set for a safety period of three days and a safety period of zero days. The reasons that the targets are set for these safety periods have to do with the agreements made between the shipping lines, Alpherium and Heineken. In the service requirements it is stated that the required containers should be available at least 48 hours before the expected loading moment at the brewery. However, Alpherium and Heineken have different planning horizons. Heineken plans on an hourly basis, while Alpherium plans on a daily basis. Since Alpherium is not fully operational at night, the argumentation of a period of three days is 72 hours, is not valid (T-0 : 0-24 hours, T-1 : 24-48 hours, T-2 : 48-72 hours, T-3 >72 hours). Therefore, the 48 hours, are translated into working days of 16 hours per day (excluding the night), resulting in a safety period of three days.

Within these three days, there is still time for corrective actions when the forecast of CA t-3 is lower than the set target and to reach the target of 100% on t-0. However corrective actions can lead to rework, extra handlings and commotion within the organizations. A high target for CA t-3 can prevent this from happening. The 90% target was established in an earlier Heineken project. A 100% target would be unreasonable, and 90% seemed, based on historical data, reasonable but ambitious. On t-0, the target is 100% with the goal to cross-dock all production.

However due to the structure of the planning process CA t-3 would be unattainable for the largest part of the week. As discussed earlier Alpherium receives a detailed production and loading plan every Wednesday which functions as the input for the barge planning which starts of every Monday. Because of this planning process, a mismatch arises in the planning considering CA t-3. When the detailed loading plan arrives at Alpherium on Wednesday, they can request the required containers at the shipping lines. The lead time for these containers, the time between request and arrival of empty container, is too long for any of the shipping lines to provide the containers three days early. E.g. when a container is requested on Tuesday it should be at Alpherium on Friday, which would mean a lead time of only one day. This is visualized in Figure 5-6. Part of the aim of the safety stock as determined by Alpherium is to make sure that the containers can still be available three days ahead.

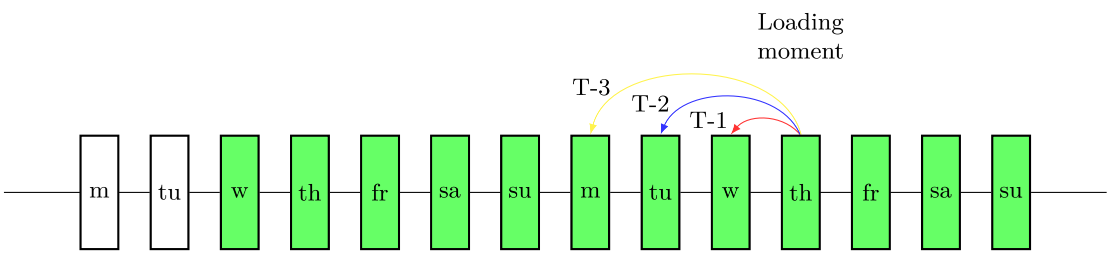

Figure 5-6: Schematic view of CA t-3, CA t-2 and CA t-1

The safety stock at Alpherium is determined based on the formula showed below. Each year the annual allocation functions as the input for a new safety stock per container colour and type.

$$\text{Safety stock} = \text{Annual allocation} * (\text{Safety lead time} + \text{Lead time}) * \text{pfactor}$$

- Annual allocation = Average demand/day
- Lead time = Time in days between container request and the arrival of the container by barge (difference per container colour and assigned depot).

- Safety lead time = Safety lead time of three days (CA t-3)
- pfactor = 1, unless a specific container colour and type shows chronic issues.

The average demand/day is based upon the forecast of annual allocation of containers at the beginning of the year. This number is divided by 300 (number of operational days). The safety lead time of three days is related to the target of CA t-3. The safety stock is determined each year, for an entire year as the output of the annual allocation. The formula contains two flexible variables: The lead time and the p-factor. The lead time can increase during the year, if a certain shipping line shows chronic problems with supplying empty containers on time. Increasing the p-factor can have different causes. E.g. if a relatively large part of containers has been rejected based on low standards. For example, if on average 10% of all containers is being rejected, the p-factor will be increased with 10% for that specific shipping line. The p-factor is determined by the terminal manager at Alpherium.

This way of determining a safety stock strongly deviates from a traditional safety stock **(source)**. One of the reasons is that the annual allocations are newly determined every year. This means there is no historical data on which the demand deviation can be determined. Without de standard demand deviation, the traditional safety stock cannot be determined. Another reason for using this formula is to be able to attain a CA t-3 of 90

Figure 5-7 shows how the safety stock theoretically works. The figure concerns an imaginary container type of an imaginary shipping line, with a forecasted demand of 20 containers per day and a lead time of two days. Using the safety stock formula from Alpherium, this results in a safety stock of 100 containers.

Safety stock = 20(2+3)*1 = 100*

The figure shows that by determining the safety stock this way, there will always be sufficient stock for the targeted three days, if a new batch of containers will be delivered after two days to replenish the stock to a 100 containers again. If the supply would arrive after three days, the stock would exist of 40 containers for the target of CA t-3. Considering the demand of 20 containers per day, this will not be sufficient supply for the coming three days. The concept is very theoretical as it assumes a constant demand and lead time. In a way, there are two stocks: a lead time stock and a safety lead time stock. The lead time stock is meant to be used during the period of a lead time in the regular process. The safety lead time stock should remain intact to foster the performance of CA t-3.

The moment the supply of empty containers is disrupted, the aim of the safety stock changes. When a supply of empty containers will not arrive at Alpherium on time, there is a three-day stock that can secure the continuity of the process. The moment the safety stock is being used, but not replenished in time, the maximum decreases. Figure 5-8 below shows the effect of using the safety stock.

The decrease of the safety stock is not always noticeable throughout the supply chain. The continuity of the process is guaranteed. But the CA t-3 is theoretically impossible to attain and the supply chain has become more vulnerable to a possible new disruption.

Other mitigating actions

Other mitigating actions frequently discussed in literature that were also used by HNS and Alpherium are briefly discussed below.

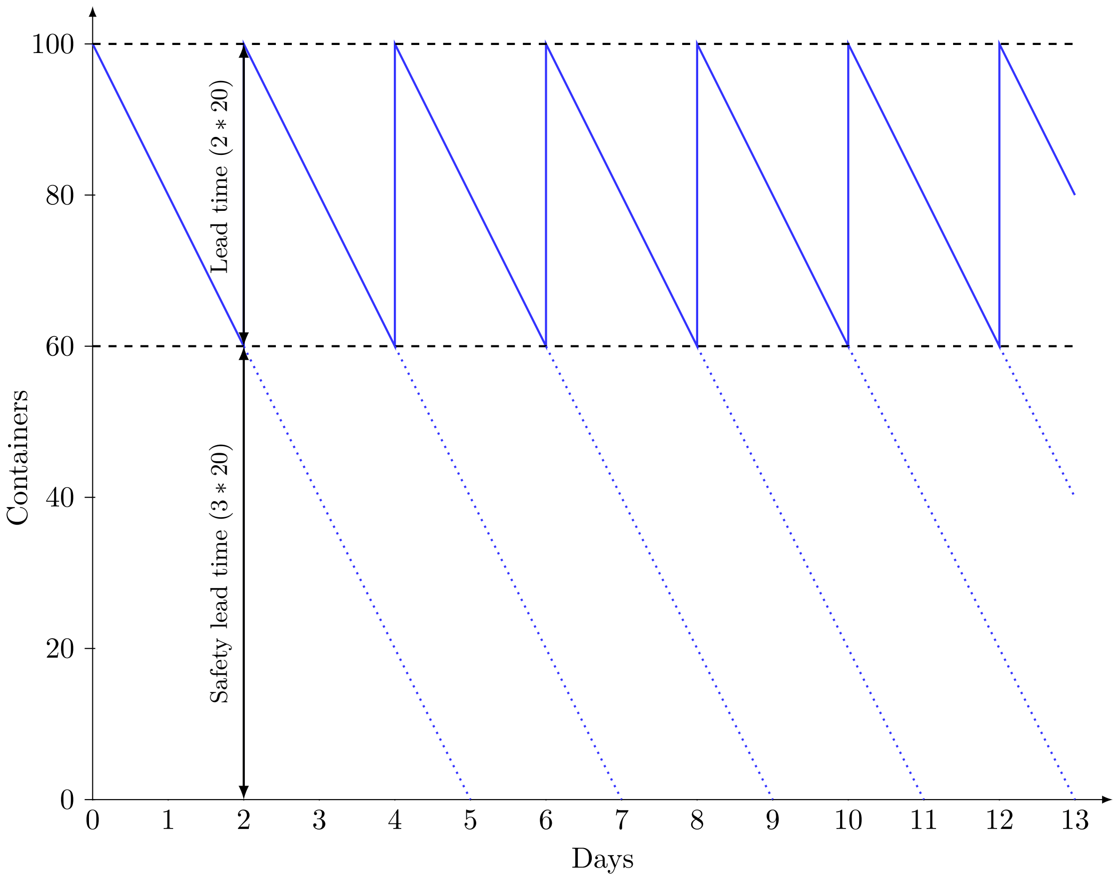

Figure 5-7: Schematic view of safety stock

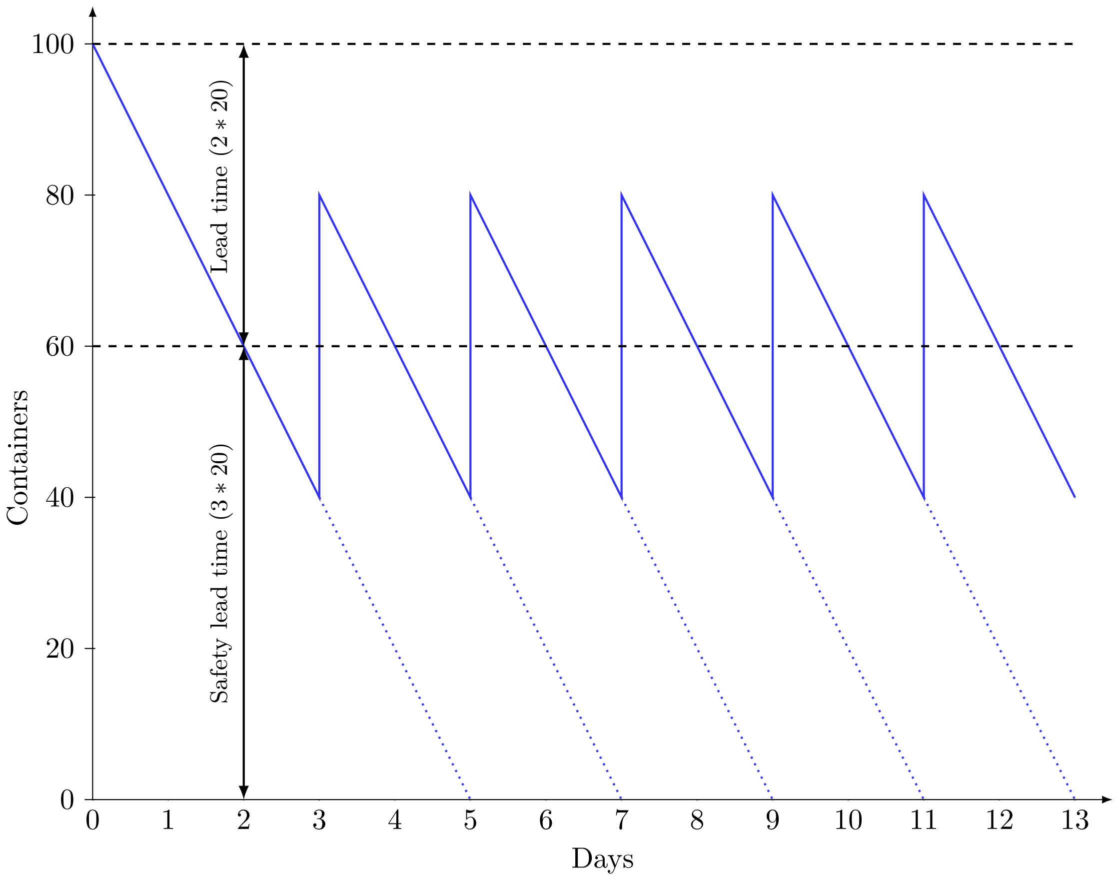

Figure 5-8: Safety stock schematically after a disruption

- Increase of capacity

In general, Alpherium works with a transport capacity higher than required. This way they can accommodate if due to the optimistic planning risks barges have to return empty to Alpherium or are significantly delayed. This shines a new light on how the barge planning deals with uncertainty. Considering the four ways as described by Walker et al. (2013), the use of extra capacity seems to indicate a more resilient approach since it accepts “short term pain (negative system performance)”. Here the pain seems to be accepted but not recovered because the extra barge capacity seems to make it unnecessary to do so. Still, recovery takes place in a form other than replacing the loss of transport capacity. After a disruption the barge planning is adapted in such a way that the left over capacity is used to supply the requested empty containers. Trips planned to add extra containers to the empty container stock are being replaced. In a way, every time a barge planning is made, a goal is set that is expected to be unattainable. Looking back at Fig 2-5 in Section 2-3, Figure 5-9 below gives a visualization of the barge planning and the difference between plan and goal. The shippers and crew of the barges can be seen as the employees who are given the task to follow the barge planning. α_1 shows the goal of the barge planning as it was when the barge planning was made. α_2 shows the actual goal, assuming that due to the high uncertainty of the barge planning, some transport capacity will be lost. A delay results in a delay of capacity supply to Alpherium, an (half) empty barge decreases the TEU supply to Alpherium. Both are depicted in the figure.

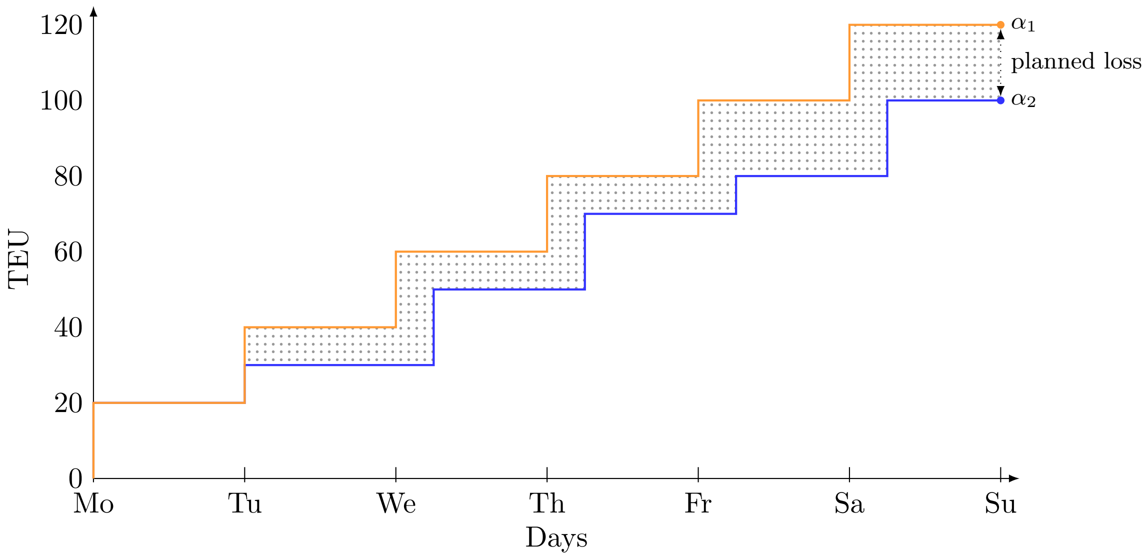

Figure 5-9: Unattainable goal setting

- Avoiding specific suppliers

Based on the stakeholder interview with the sea freight contract manager, it can be stated that the main variables included in the consideration of different shipping lines are prices and transit times. Reliability of the supplier is not part of the consideration. However, it has happened that collaborations were not renewed as the result of disappointing outcomes concerning the CA. This only accounts for the smaller shipping lines, and not all shipping lines offer the same destinations and transport volumes. Alpherium and HNS work with multiple suppliers, but this is not a risk mitigating strategy. None of the suppliers are redundant as the CA depends on specific container types and colours. It is the result of products and shipping lines being dedicated to specific destinations, making it difficult to work with only one or a few shipping lines. Interesting to see is that the use of multiple suppliers, in this case results in added complexity of the supply chain. Having only one supplier would make the overall planning process a lot simpler.

- Sharing of risk related information.

Chapter 4 describes the planning processes and the different information flows that take place between the different stakeholders. The different monitor processes described in Table 4-1 facilitate the sharing of risk related information. Besides these monitor processes, the daily STAVAZA-email conversations between Alpherium and the barge planners at Van Uden are used to share risk related information as well. Sharing of risk related information can be linked to the SC-disruption cycle. Accurate and timely information sharing can help the organization to earlier discover situations that might be labelled as abnormal and therefore earlier detect disruptions (Yang & Chen, 2007; S. Li & Lin, 2006; Lee & Whang, 2000; Behdani, 2013).

5-2 Supply chain disruption management at the inland terminal

5-2-1 Detection

In order to deal with a disruption, it is of most important to detect a disruption as soon as possible (Behdani, 2013). Alerting the disruption timely throughout the organization(s) can support the decision making process that is aimed at limiting the impact of a disruption (G. Li, Lin, Wang, & Yan, 2007). Alerting can be done through sharing of risk related information or through implementing warning systems or systems that support the monitoring of the performances related to the critical objective (Behdani, 2013).

In general, the monitor processes and STAVAZA-emails facilitate the different stakeholders to share information about occurring disruptions. However, in order to provide an insight into the impact of a disruption Alpherium uses the CA-file.

CA-file

Alpherium uses this file to monitor the CA performances. Although it does not detect a disruption, it can detect an insufficient CA as the result of a disruption and helps to provide an insight into the impact of a disruption and where the impact hits the CA.

The CA file links the barge planning and the detailed loading plan to the empty container stock at Alpherium, per container colour and type. The file shows the expected CA with the three different safety periods and therefore provides both the expectations for CA t-0 and CA t-3. Figure 5-10 shows a small part of the CA-file. It can be seen that per container colour and type, the prior determined safety stock is listed. Furthermore, the table shows the expected number of containers to be requested per day, and the expected supply per day. The request and supply in combination with the current empty stock at the terminal determines the CA per container colour. The supply is the output of the barge planning and the expected requests are the output of the detailed loading and production plan. Thus, if due to a disruption (part of) the transport supply will be lost, the effect on the CA can be retrieved through the CA-file.

depot	type	veiligheids voorraad	datum	za 05-11	zo 06-11	ma 07-11
			Verwachtte afroep	0	0	0
[redacted]	20DV	15	**Voorr. op terminal**	**13**	**13**	**13**
			Verwachtte aanlevering	0	0	0
			Verwachtte afroep	0	0	0
[redacted]	40DV	0	**Voorr. op terminal**	**5**	**5**	**5**
			Verwachtte aanlevering	0	0	0
			Verwachtte afroep	0	0	0
[redacted]	20DV	0	**Voorr. op terminal**	**3**	**3**	**3**
			Verwachtte aanlevering	0	0	0
			Verwachtte afroep	0	0	0
[redacted]	20DV	11	**Voorr. op terminal**	**25**	**25**	**25**
			Verwachtte aanlevering	0	0	0
			Verwachtte afroep	0	0	0
[redacted]	40DV	133	**Voorr. op terminal**	**102**	**102**	**102**
			Verwachtte aanlevering	0	0	0

Figure 5-10: Example CA file

5-2-2 Reaction

As discussed in the previous paragraph, a major disruption could result in shutting down the production process which should be prevented at all costs. If such a major disruption occurs a pre-defined plan can help limit the reaction time (Wagner & Bode, 2006). Together HNS and Alpherium made such a plan, which is referred to as the contingency plan. The reaction step is only required when current mitigating actions have failed to prevent a disruption from harming the critical objective.

Contingency plan

In order to make sure to contingency plan is only activated when necessary, a number of triggers were linked to the contingency plan.

- If (it is expected that) there is no supply of empty containers for over 48 working hours
- If the safety stock reaches a number below a pre-defined level (determined based on annual allocation)
- If the stock of loaded containers is higher than 1350 TEU (Van Baal, 2014)

The current contingency plan predominantly includes information on who will have to come together, how many times and who has to be informed. It includes a Management Control Reporting System (MCRS), which elaborates on the aim of the contingency plan, as well as the input and output. The aim is described as "determining measures and defining decisions when the contingency plan is activated". The input is the cause, the expected duration and the impact of the disruption as well as the forecast of production. The output exists of a follow-up appointment and an email containing information about the disruption and the determined measurements that is sent to a number of predefined actors. The stakeholders involved in the contingency meeting are the terminal manager of Alpherium, the barge planner, the loading planner and a team leader of the brewery. The sea freight contract manager is often present as well (Van Baal, 2014)

Some disruptions have a small impact which can be dealt with through switching production, rescheduling, storing or adding transport capacity in the form of truck transport. With these actions the impact on the CA does not have to harm the cross-docking of production, and the system can be quickly returned to its desired state. If none of these steps bring the overall system back to its desired state, the organization takes the step of disruption recovery.

5-2-3 Recovery

The safety stock as a risk mitigation action can absorb impact of a disruption to a certain extent. After reaction took place there are several possible situations.

- Recovery is not required

If during the reaction period the above described actions have been able to restore the normal operation and the safety stock has remained on its pre-determined level, there is no need for recovering actions.

- Recovery of safety stock is required to attain CA t-3

As discussed earlier, the safety stock serves two different goals. It supports the attainability of CA t-3, and in case of a disruption it functions as a regular buffer stock. If during a disruption, the latter was the case the safety stock will have decreased to a level where it can no longer support attaining the target of CA t-3. In order to recover the safety stock back to this level, adding transport capacity could be an option. Another option would be to use the extra barge capacity to replenish the safety stock over time, to the level where it can attain the CA t-3 target again.

- Recovery of safety stock is required to restore the normal operation

A disruption with a bigger impact can decrease the safety stock in such a way that it no longer can function as a buffer stock and the target of CA t-0 becomes unattainable. If this is the case the only way to recover is to add transport capacity. During the week transport capacity can be added in the form of truck capacity. When creating a new barge planning for the week following the disruption, barge capacity can be added to restore the safety stock and secure the target of CA t-0 by restoring the operations to normal. This means that the barge capacity is added to the capacity that would have been planned for that week's demand. E.g. when demand from HNS requires five barges, the barge planner can add a sixth barge to restore the safety stock in order restore the CA t-0.

Figure 5-11 shown below is derived from Sheffi and Rice Jr (2005). It shows the disruption profile where the impact of a disruption on an organization's performance is shown over time. Based on the figure it can be stated that a shorter preparation time for recovery can speed up the recovery of the performance. Thus having a pre-defined plan can decrease the preparation time, and limit the impact of disruption as it recovers more quickly (Sheffi & Rice Jr, 2005).

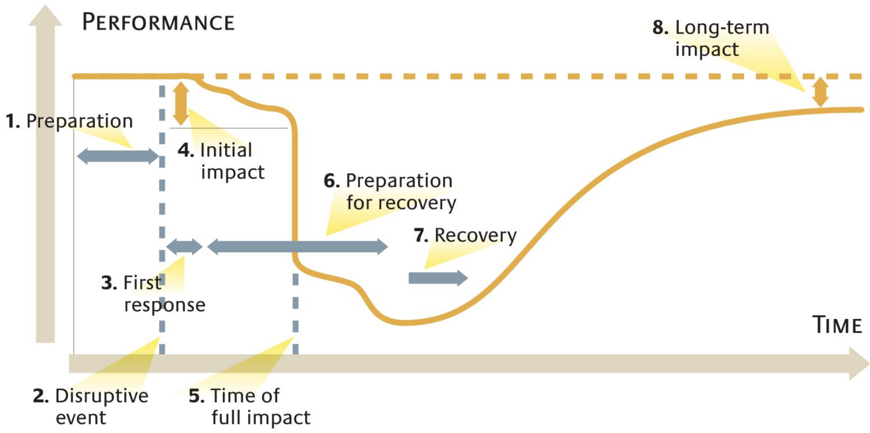

Figure 5-11: The disruption profile. Retrieved by Sheffi &Rice (2005)

5-2-4 Learning

The final step in the disruption management cycle is the one that can be linked to the start of the SCRM cycle. Evaluation of contingency situations can help both organizations learn from disruptions and if they should adapt new mitigating actions or change the predefined plans. Currently there are no pre-defined learning steps, besides the evaluation of a contingency situation.

5-3 Inter-organizational collaboration between Alpherium and HNS

As can be derived from the previous paragraphs, when it comes to risk monitoring, disruption detection and reaction, sharing of information is of crucial importance. Section 2-2 discussed the challenges that come with inter-organizational collaboration and how this can influence the performance of the collaboration and therefore the collaborative efforts to manage supply chain risks and disruptions, including sharing of risk-related information.

As stated in the theoretical framework, inter-organizational collaboration performances are influenced through the amount and quality of information sharing (L. Li, 2005). However, an inter-organizational collaboration can possess certain characteristics that hinder partnership performances. Besides information sharing facilities as information communication technology, social factors can play a role as well. The presence or absence of these factors could increase or decrease the impact of a supply chain disruption or the effect of supply chain risk management (Barratt, 2004; L. Li, 2005; Paulraj et al., 2008). Spekman and Davis (2004) state that supply chain partnerships can be seen as learning organizations that can learn to easily adapt and respond to changes and/or disruptions. In order to achieve such learning capabilities, information sharing should be optimized. Whether or not the collaboration between HNS and Alpherium has the characteristics to strengthen or weaken SCRM or SC-disruption management was analysed.

In order to do this, the outcomes of the stakeholder interviews are analysed based on the inter-organizational factors listed in Section 2-2. Most literature about information sharing in supply chain partnerships or inter-organizational collaborations focusses on strategic partnerships. Alpherium and HNS form a strategic partnership, in the form of a long term relationship. The relationship with the shipping line is considered as an external factor. Every year a new annual allocation is made, and the shipping lines have no long term agreement with HNS. Therefore, the relationship is not considered a strategic alliance. On the other hand, most shipping lines have been working with HNS for many years. Still, the relationship between shipping lines, Alpherium and HNS is considered one that could not be influenced through this research and is therefore excluded from it.

In order to organize data retrieved from the stakeholder interviews the process of coding is applied. The technique used is a predominantly closed coding. Open coding aims at creating concepts, that can later be grouped into categories in order to create a grounded theory (Bryman, 2012, p.569). Closed coding, on the other hand, aims at finding proof for theoretic concepts (Bryman, 2012, p.569). For this research a mixed method was chosen as a result of the interview structure. The interviews were conducted without a strong theoretical foundation and therefore do not give clearly theoretical related outcomes. Considering the fact that in order to identify the social factors influencing the supply chain partnership, a theoretical foundation is required, we link the outcome of the interviews to theoretical categories. The type of interview was a semi-structured interview (Bryman, 2012, p471).

The method of coding is subject to the researcher's interpretation and therefore offers a debatable outcome (Saldana, 2009) The first step in this coding method was to underline parts of the transcribed texts that possible could be linked to factors influencing the supply chain partnerships. Subsequently these parts of the text were interpreted by the researcher. The interpreted quotes are then linked to the theoretical codes. Finally, a conclusion will be given about certain characteristics of the collaboration between HNS and Alpherium.

The results of coding can be found in Appendix C. The partnership between Alpherium and HNS shows many aspects that positively influences the partnership performance.

The frequency of information sharing is high, it is done well-structured and both parties showed no reluctance to share any information. The loading planner from the operational planned department stated "I have no secrets for Alpherium". Frequent sharing of information helps build trust and can reduce conflict (Sodhi & Son, 2009). Structured information exchange is important as it can support the decision-making process surrounding risks and disruptions (Behdani, 2013; Chen et al., 2010).

A frequently discussed topic in the interviews was the timeliness of shared information, which also seemed to be an influential factor to the perceived satisfaction and trust in Alpherium from the viewpoint of the interviewees of HNS. Timely sharing of information, especially in times of high supplier uncertainty were considered very important by the interviewees of HNS. It is assumed that this could be linked to the stated importance of pro-activeness. From the interviews it was interpreted that in order to deal with supplier uncertainty and to secure performance during disruptions or in situations of high risks the partnership should follow a proactive policy. Timeliness is considered an aspect of information quality. To deal with uncertainties and unpredictable events, information should be shared without distortions and on time (S. Li & Lin, 2006). Thus this matches the statements of the interviewees where they indicate the importance of timely sharing, in order to manage risks and disruptions adequately.

Besides enabling a proactive policy, timely sharing of information was deemed important because of the partner asymmetry between HNS and Alpherium. Stated by both interviewees from Alpherium/Van Uden and HNS, the powerful position of Heineken as a shipper with high volumes could be used as a crowbar to get demands trough with the shipping lines and in some cases the terminal operators. If Alpherium would experience issues with one of the contracted shipping lines they could involve HNS to exert influence. This is considered an interesting phenomenon since the existence of partner asymmetry is expected to negatively influence the partnership performances (Sodhi & Son, 2009). Here it seems that the partner asymmetry is used to attain a positive outcome. Besides positive outcomes, the partner asymmetry seems to create a higher level of attitudinal commitment from Alpherium to Heineken. Collaborating with a partner of the calibre of Heineken seems to create a more powerful position of Alpherium in the overall play field of shipping lines and terminal operators. The partner asymmetry in this case offers opportunities instead of forming a risk to the collaborative outcomes. It shows here that the attitudinal commitment as described by Cullen et al. (2000) overrules the negative effects of partner asymmetry.

Another frequently coded topic was trust in the supply chain partner. Remarkably the codes related to trust were all but one linked to trust HNS has in Alpherium and not the other way around. Benevolent trust was predominantly labelled as high. This means that in general the interviewees of HNS consider the attitudinal commitment of Alpherium high and believe in their goodwill. The level of credibility trust, 'trust in the ability of Alpherium to meet their obligations' was interpreted as low (Cullen et al., 2000). Overall interviewees at HNS seemed to feel the need to check actions performed by Alpherium and also mentioned their need for optimization a risk to the goals set by HNS. Another reason for the low level of credibility trust was the belief that Alpherium should improve on their proactive policy. The low level of credibility trust could decrease the perceived satisfaction and through that further decrease overall trust in the partner. A low level of trust is considered an issue as it can lead to partners holding back information or unfair treatment. Besides that, trust provides a 'foundation for commitment' resulting in long term relationships (Cullen et al., 2000). Kwon and Suh (2004) state that "a lack of trust among supply chain partners often results in inefficient and ineffective performance as the transaction costs mount". They also describe how trust can be considered of crucial importance in supply chain partnerships as it involves "a higher degree of interdependency". Considering the interdependency between Alpherium and HNS, this is very applicable. Sahay (2003) states that trust can be built through certain behaviours, e.g. "pro-active information sharing about likely problems in the future". The low perceived satisfaction about the pro-active policy of Alpherium could indicate why the level of credibility trust shows room for improvement.

As focal organization, Alpherium did not seem to discuss topics that were interpreted as trusting behaviour, making it difficult to provide a statement of the level of trust Alpherium has in HNS as their partner. Since interviewees were not explicitly asked about trust in their partner, a possible explanation could be that the overall highly perceived satisfaction implies a high level of trust. Another explanation might be that the interdependency between both organizations and the long term orientation decreases the chance of HNS taking advantage of Alpherium which can result in high benevolent trust (Cullen et al., 2000). One quote was interpreted as relating to high benevolent trust of Alpherium in HNS, stating they "now work with people who want to work that way" referring to the presence of shared vision. Shared vision supports inter-organizational partnership performances (Rajaguru & Matanda, 2013).

Considering the vision similarities and differences it can be stated that the overall goals and visions are similar. Both parties focus on the CA in order to optimize the overall process and have a long term vision considering durability of the supply chain. One issue that arose from the interpretation of the interviews was the issue between the need of Alpherium to optimally use their transport capacity and the high level of service requested by HNS. If due to Alpherium's optimization HNS misses its target or if HNS requests actions from Alpherium that will increase their operational costs it could lead to friction. This difference in shared vision could lead to a decrease in information sharing, as it might trigger holding back information, forming a risk to the partner performances (S. Li & Lin, 2006). However, the risk is assumed to be relatively small as the overall critical objectives and visions are similar.

Besides shared goals, organizational culture can influence the level of shared vision between organizations. We already saw how the partner asymmetry related to power, resulted in high attitudinal commitment from Alpherium towards HNS. However, according to Sodhi and Son (2009) differences in organizational characteristics usually negatively affect he partnership performances. L. Li (2005) states that similar organizational cultures can support commitment between partners. Organizations should have compatible cultures to attain joint management, as the way and need of information sharing is driven by an organizational culture (Hatala & Lutta, 2009). Overall the partners show more cultural differences than similarities. One of the HNS interviewees considered Heineken as a more professional and well-structured organization compared to Alpherium. Besides this, Heineken and Alpherium are considered to be two very different organizations. And even though this did not explicitly came up during the interviews, it can be stated that Heineken as a successful multi-national possesses very different characteristics than an inland terminal serving approximately four clients. These cultural differences can be considered a risk as it implies different ways and needs of information sharing and long term visions, but it seems to also be an indicator for attitudinal commitment within this case study.

Environmental uncertainties as supplier uncertainty and customer uncertainties are interpreted as high. The supplier uncertainty, from the focal organization Alpherium is considered to be the uncertainty caused by the shipping lines and deep sea port dynamics. The interviewees from HNS seem to confirm this source of supplier uncertainty. S. Li and Lin (2006) state that supplier uncertainty can lead to a decrease in information sharing. The case study seems to show contradicting results. In the interviews, the supplier uncertainty is often linked to the timeliness of information sharing. It seems that in order to deal with the supplier uncertainty, HNS requests from Alpherium to timely share this uncertainty with them in order to deal with the uncertainty together. Thus supplier uncertainty increases the sharing and quality of information exchange. This matches the theory stating that a high environmental uncertainty requires a high frequency of information exchange (Wei et al., 2012). To reflect on the statement made by S. Li and Lin (2006), it is assumed that the supplier uncertainty they speak of is related to the level of trust in the partnership. They state that supplier uncertainty can reduce information sharing “since organizations may find it too risky to share information with suppliers of high uncertainty”(S. Li & Lin, 2006). Thus the level of trust in the supply chain partner can be considered low. In the case study, the supplier uncertainty is created by an external supplier and does not seem to influence the level of trust but does request an increase in information exchange. In regards to the customer uncertainty,S. Li and Lin (2006) state that nor information sharing nor quality of information are influenced through customer uncertainty. The outcomes of linking the interviews do not seem to underline this statement, as the loading planner stated the he considered the information exchange considering demand between OS and Alpherium as a great risk. He stated “the weekly forecast is a huge risk, so the transition of the week, in which we cannot or can not sufficiently provide the inland terminal Alpherium (OTA) with an idea on which containers they will need the coming week”. He considered it as his personal goal, to make sure no distortions or delays would increase this risk. Chopra and Sodhi (2004) consider forecast inaccuracies as a supply chain risk in the form of information distortions. This corresponds with the statement made by the loading planner and the identified risk levels in the previous section. Information distortions are considered as a lack of information quality. However we cannot say with certainty that the quality and frequency of information exchange is influenced through demand uncertainty, as Chopra and Sodhi (2004) and the loading planner underline the need for high quality and frequency but not the actual increase itself as a result of the customer uncertainty.

Overall on a strategic level the outcome of the interviews showed that the presence of joint partnership management was well noticeable throughout the collaboration between the two parties. Especially as part of the problem solving management, illustrated by these quotes given by the terminal manager and the barge planner: “the moment a line stagnates, Leiden is in trouble, so we want to prevent that at all costs and that is possible when looking at it with everyone”; “so then the planning expires, and you have to switch together. I adapt the planning in collaboration with the shipping line and Heineken”. Joint partnership management and decision making reduces information asymmetry and increases information exchange (Sodhi & Son, 2009). The interview outcomes seem to underline this statement.

A remarkable outcome of the coded interviews was the mentioning of a high staff turnover and the possible effect it has on the exchange of information between Alpherium and HNS. One HNS interviewee stated that the high staff turnover at his department (CSE) implied that the knowledge would decrease and not everyone at the department would be aware of the effect of their actions on Alpherium’s operations. Another quote interpreted as related to staff turnover was given by the terminal manager. He stated that a shift in staff resulted in having the right people at the right positions for the collaborative performances. This quote indicates that the collaborative performances are influenced by the people part of the collaboration, and staff turnover could diminish good performances. This is considered a risk, stating that a high staff turnover results in less experienced organization members which could decrease internal knowledge and result in a decrease of information quality and the awareness of the importance of information exchange. Staff turnover could be added to the theoretical framework of partnership performance influential factors in the future (Yang & Chen, 2007).

Chapter 5 answers the first four sub questions on the basis of the case study. A summary of these answers can be found in Chapter 10-1.

Chapter 6

Defining the gaps and setting up requirements

Now that we have discussed the different supply chain risks, mitigating actions and disruption management from the viewpoint of the inland terminal, the next step is to identify the gaps in the current practices and how these can be addressed.

CA t-3 recovery

During the analysis of the current mitigating actions as part of the collaboration between HNS and Alpherium, it came to light that after a disruption CA t-3 recovered slowly. Figure 6-1 shows the course of CA t-3 over a number of weeks in 2015. The red text boxes indicate a disruption occurred that week. It can be seen that CA t-3 drops heavily after a disruption and takes some time to recover back or close to its set target of 90% (not all disruptions are included as a red text box in the figure).

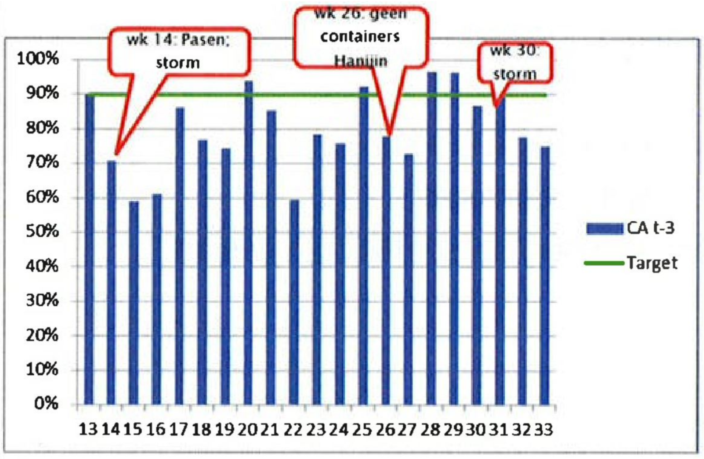

Figure 6-1: Recovery CA t-3

Based on the analysis of the current SCRM and SC-disruption management, it was found that the safety stock serves two goals: providing containers three days before the expected loading moment (CA t-3) and absorbing the impact of a disruption to the supply of empty containers to Alpherium. Depending on the magnitude of a disruption, CA t-3 or CA t-0 could be impacted, as was depicted in the Figures 5-7 and 5-8. It was also found that recovery actions are determined based upon the prior discussed CA-file, with a focus on container type and colour and not on the loss of transport capacity. The loss of transport capacity planned to replenish safety stock is therefore not taken into account when looking for recovery actions. Besides, during the recovery phase the focus lies completely on CA t-0. Priority of CA t-3 is low, as an insufficient CA t-3 does not necessarily pose a risk to the moment of cross-docking. In other words, the effect of an insufficient CA t-3 is not noticeable throughout the process. The combination of focussing on CA t-0 and the impact per container type and colour, results in recovery actions that do not address the overall impact of a disruption. Because the transport capacity planned to recover from the disruption has not taken into account the lost capacity used to replenish the safety stock to the level of CA t-3, the safety stock will not be restored to its desired level. Resulting in an unattainable CA t-3 target. When after a disruption the operation has returned to normal, the extra transport capacity can over time replenish the safety stock. The higher the impact, the longer this will take, and during this recovery phase the overall process is more vulnerable to a new disruption because mitigating actions can absorb less of a new disruption's impact.

Besides a slow recovery of the safety stock, another negative effect of the focus on detailed level per container type and colour is that the impact of a disruption is difficult to translate to other departments within HNS. The lack of a high level overview makes it difficult to link the impact to an expectation of recovery time, and provide an insight into what recovery actions were considered. This lack of insight can result in a further decrease of the credibility trust, as others are uncertain if all recovery options were considered and the best decision was made (Cullen et al., 2000; Wei et al., 2012).

Lack of detection

Besides the recovery of CA t-3 another issues came to light during the analysis of the SCRM and SC-disruption management at Alpherium and HNS. As described, Alpherium usually sails with extra barge capacity to absorb the effect of planning under high uncertainty. This way small disruptions, like a barge delay or a barge sailing with two layers instead of three for one trip, have no impact on CA t-0 or CA t-3. In general, Alpherium could lose two trips in total, before it impacts any CA target. However, currently there is no detection or registration method that detects whether or not a number of smaller disruptions together exceed the limit of two trips. If the limit would be exceeded, it could form a risk to the attainability of CA t-3 and an increase of the process's vulnerability.

Safety stock

The safety stock as determined at Alpherium strongly deviates from a safety stock as described in literature.

Traditionally, a safety stock has the purpose of absorbing demand variances and lead times to prevent a stock-out from happening. The safety stock is determined based on the demand variance, lead time and the service level (King, 2011; Durlinger, 2013; Tratar, 2009). The service level is a percentage that represents the amount of times one is allowed to have a stock-out or the percentage of the number of products that cause a stock-out (King, 2011).

The safety stock is not a way to prevent all stock-outs but the majority of stock outs. The higher the service level, the smaller the chance on a stock-out. A higher service level automatically results in a higher safety stock and higher stock costs. The height of the service level is usually determined by an organization's management. Important to state is that a service level can never acquire 100%, this is considered statistically impossible (Durlinger, 2013; King, 2011).

When the service level, the lead time variance and demand variance are determined, the required safety stock can be calculated. The formula below shows how a safety stock is determined when the lead time is not a constant.

$$VV = Z\sqrt{\sigma_d^2 * LT + \sigma_{LT}^2 * D^2}$$

- σ_{LT}^2 =Standard deviation in lead time
- D=Average demand
- Z=Safety factor depending on the service level (retrieved from table)
- σ_d^2=Standard deviation of demand
- LT=Lead time

One of the reasons that Alpherium does not use the traditional safety stock formula is that the annual allocations are newly determined every year, while the safety stock is based on those allocations. Therefore, there is no historical data that can help determine the demand variance. Without the standard deviation on demand the traditional safety stock cannot be calculated. Thus, Alpherium uses a forecast of the daily average based on the annual allocation to calculate the safety stock, not taking into account volatilities in demand. The reality is very different from such an average demand. The container demand can variate strongly on a week or even a daily basis as was shown in **Section 5.1.4**. This variance in demand of course influences the performances of the safety stock. This could result in stock outs and surpluses of container stock.

A limitation to the safety stock as determined by Alpherium can be found in the fact that not all container types and colours have a safety stock. A safety stock is only used for those container types that have an annual allocation higher than 400 containers per year. This way it is prevented that empty containers remain at Alpherium unused for a long period of time, possibly resulting in issues with the shipping line and it takes into consideration the capacity limitations at Alpherium. The effect of not having a safety stock for a part of the allocated containers, means that for a large part of the week, the CA t-3 is not attainable. The share of allocated containers without a safety stock in 2016 is around 5% of the overall allocation. This means that the target of 90% for the CA t-3 remains realistic.

Current method of barge planning

The current method of barge planning, as depicted in Figure 5-9, sets an unattainable goal to the shippers and crew of the barges. As discussed in Section 2-3, Goldratt (1997) named a number of psychological factors that could increase the duration of the activities. It is assumed that through aiming lower than planned, these psychological factors could be stimulated. The student syndrome, Parkinson's law and the other factors mentioned all prevent an activity from being finished before the given time. Considering the "Theory of Goal setting and Taks Motivation" by Locke and Latham (2002) as described in Section 2-3, the unattainable goal on the one hand, can lower commitment of the shippers and crew of the barges. On the other hand, knowing that the pre-defined barge planning is not their actual goal, it could also reduce effort and the ambition to decrease round trip times. The fact that the pre-defined planning is not expected to be realizable, results in a lack of incentive to the shippers and crew. Without the belief of being able to realize the barge planning and the belief that good behaviour will result in rewards "the force to act" is limited (Locke & Latham, 2002). This is assumed to contribute to the degree of risk of the barge planning under uncertainty.

Contingency plan

During the analysis of the case study, a port wide strike took place on January the 7th 2016 for 24 hours (ANP, 2016). During and prior to the strike, the contingency plan was activated. Already during the prior set-up meetings, it became clear that not all required information flows were included in the current contingency plan that would support taking the optimal decision. Knowledge on stocks in the market had to be attained, as well as information on what production had a high priority of reaching the customer in time.

Afterwards, friction emerged between HNS and Alpherium as there was disagreement about certain costs that were made for recovery actions. This was assumed to be the result of a lack of clarity about the goals during a contingency situation. Alpherium made costs to transport loaded containers in time at the assigned deep sea terminal, while Heineken stated that these containers did not have a high priority and therefore the costs did not have to made. Such situations can lead to a decrease of trust from both parties, as it limits the predictability of the parties' actions or could feel like unfair treatment (Sahay, 2003; Cullen et al., 2000).

Now that we have identified the gaps of the current SCRM and SC-disruption management at HNS and Alpherium we set up requirements that a measure should meet in order to improve the current state of affairs. These requirements are:

- An overview should be provided of the impact of a disruption on the overall transport capacity, so that the recovery actions incorporate the effect on the safety stock and its goal to provide the containers three days prior to the loading moment (CA t-3).
- It should include information on how long recovery is expected to take. It should also provide an insight into what options can be considered as well as an estimation on the related extra costs so that the reasoning behind a chosen recovery option is clear. It should be done in such a way, that it is translatable throughout both organizations.
- It has to support detection of smaller disruptions exceeding the limit of overcapacity.
- Offer well-structured support for information exchange.
- It should support increasing trust from HNS in Alpherium in order to improve inter-organizational collaborative performances.

On the other hand, the measure should not:

- Increase reaction time when a disruption occurs

Besides a measure that can help recovering CA t-3 sooner as well as registering and detecting smaller disruptions, the evaluation of the contingency plan should be taken into account. The strike at the port of Rotterdam is a perfect example of the learning step from the SC-disruption management cycle. It was found that the current pre-defined plan was not sufficient and should therefore be adapted. The limitations of the safety stock will also be addressed. Due to time restrictions, and the focus of the problem owners on the recovery of the CA, the defined gap of planning method is not addressed in the suggested measure or in any other way.

The next part of the report describes the development of such a measurement. It is important to state, that it is an example of how such a measure could look like, not what the most optimal measure looks like.

Part II

Tool development and evaluation

Chapter 7

Disruption impact model, decision support tool and adaptations of current mitigating actions

The tool including the model was developed based on the insights gained by the researcher during the analysis period at HNS and Alpherium. The same accounts for the adaptations of mitigating and detection actions. It therefore offers a subjective outcome, combining the outcome of research and own personal insights of the researcher which is not empirically derived. The evaluation of the suggested adaptations is based upon testing of the tool, conversations with stakeholders and a review of the literature.

7-1 Development

Based on the requirements listed in the previous chapter, a tool was developed that helps the barge planner at Alpherium to quickly estimate the impact of a disruption on a transport capacity level. The way of calculating the impact in theoretical maximum supply capacity (TMA), as described in Section 5-1-3 formed the input for the development of this tool.

During the risk quantification step, it was found that a disruption's effect on transport capacity was a way to quantify an expected impact of a disruption. Depending on the duration as well as other factors, the impact could be estimated through calculating the loss of transport capacity and therefore the loss of empty container supply. As stated earlier, a big part of the different identified risks can affect the transport capacity directly or indirectly and can therefore be quantified through the impact on the supply capacity.

Calculation disruption impact

In order to use the calculation to estimate a disruption's impact, the calculation of TMA was incorporated in an Excel-table. Since the calculation is based upon the barge planner, the task of estimating the impact was assigned to the barge planner. This was done as follows:

- First the different types of impacts were linked to the matching calculation. Thus a disruption that results in a limitation in the number of container layers, an empty trip, non-sailing hours or added sailing hours should be correctly linked to a different calculation. These calculations are discussed in Appendix F.

- For every week, per barge a TMA-calculation is made. The barge planner can manually adapt the TMA according to that week's barge planning and through this, calculate the TMA specifically for that week.

- The Excel-file is made in such a way, that the barge planner only has to fill in the number of times a barge had to sail empty, had an empty trip or the amount of hours a barge could not sail or had to sail extra. This way the formulas pre-entered in the Excel-file calculate the disruptions in TEU.

- The next step is that based on the disruption as calculated in TEU, the Excel-file calculates the difference between prior determined TMA and the TMA with the impact of the disruption incorporated. Thus showing an estimation of the transport capacity loss as an impact of a disruption or disruptions in TEU.

For a number of reasons, we chose to develop the tool in Excel. The calculation is relatively simple, and does therefore not require mathematical software. The barge planner already performs all his tasks in his Excel (CA-file, trigger file, barge planning), and would therefore not need any additional training to use the tool. The way the tool was developed, also offers the registration of disruptions, which will be elaborated on later.

Tool design screen shots are shown in Appendix H. The aim of the steps described above is to provide the barge planner an overview of an estimation of a disruption impact on the transport capacity. This way the impact calculation includes the loss of transport capacity which would have been used to replenish the safety stock. Expressing the impact in TEU, is translatable throughout both organizations as 1 TEU is easy translatable to one 20ft container, and 2 TEU to the more common 40ft. container.

Decision support

The next step in developing the tool, was to find a way it could support decision making concerning recovery of a disruption. Where the output of the first part; an estimation of the impact of a disruption on transport capacity (TEU) functions as the input to the decision on recovery actions.

As stated earlier, recovery can be done through adding transport capacity in the form of truck or barge transport. Truck transport can, in some cases, be used one day after or even the same day of requesting. Barge transport can be used only as part of a new barge planning, and can thus be used a week or a few days later. In order to support the decision making process considering adding transport capacity, a rough estimation on costs should be made in order for the decision makers to make a well deliberated choice on recovery actions.

The costs for a barge per day were found in the tariff-agreements of 2016 made between HNS and Alpherium. The costs differ if a barge is sailing to Antwerp or Rotterdam. Based on the annual allocation it was found that approximately [redacted]% of all containers loaded at Zoeterwoude are transported via Antwerp, and the other [redacted]% are transported through Rotterdam. We adopted this distribution in order to calculate an average estimate for barge costs per day. Based on conversations with the barge planner and terminal manager at Alpherium, it was determined that an extra barge (a barge used for recovery actions and not that week's container demand) usually uses [redacted]% of its capacity. An average barge has a capacity of [redacted]%. It is assumed that a barge visits Alpherium once per day.

Table 7-1: Average barge costs

	Barge costs per day estimation
Rotterdam	€ [redacted]
Antwerp	€ [redacted]
Average	€ [redacted]

Considering the other option, using truck capacity, the average costs per truck per day should be estimated as well. For estimating the truck costs per day, we use the same Antwerp/Rotterdam distribution as used for the estimation of average barge costs. A big difference is that a truck can visit Alpherium multiple times per day, while with the trip times, a barge visits Alpherium maximum once a day. In consultation with the barge planner and terminal manager at Alpherium, it was assumed that a truck could make on average 3 round trips when visiting Antwerp and 5 round trips when visiting Rotterdam. This results in an average number of round trips of [redacted] ([redacted]%*3+[redacted]%*5). With this information we can make an estimation of truck costs per day.

Table 7-2: Average truck costs

	Costs per roundtrip truck at the request of Heineken	**Truck costs per day estimation**
Rotterdam	€ [redacted]	
Antwerp	€ [redacted]	
Average	€ [redacted]	€ [redacted]

Knowing the costs estimation, the decision support of recovery actions can be created. As stated earlier the estimation of lost transport capacity in TEU is the input of the decision support. Knowing the average capacity per truck (on average [redacted]% 40ft, [redacted]% 20ft and [redacted]% 45ft based on the annual allocation of 2016) and per barge, a model was made that can provide the barge planner with an overview in the costs and duration of recovery actions. The variables are the number of trucks and barges and can be filled in by the barge planner. The formula that calculates the duration of recovery is shown below. The duration is calculated in days.

$$\text{duration of recovery} = \frac{\text{Loss of capacity (TEU)}}{N_{\text{barges}} * \text{AC}_{\text{barge}} * 1 + N_{\text{trucks}} * \text{AC}_{\text{truck}} * 4.5}$$

- N = Number of barges

- AC = Average capacity

After estimating the duration of recovery, the related costs are linked to the duration and the added capacity. Thus the number of days, times the estimated costs per day.

In general, the costs do not differ, as the capacity that needs to be recovered is directly linked and does not change. The duration of recovery however does, as well as the difference in costs between barge and trucks. It therefore provides an overview of expected costs, and related duration plus it shows the barge planner if adding an extra barge to next week's planning is feasible. Hiring a barge for a use of 1 or 2 days is not very realistic as it is not financially feasible for the barge operator. Based on these insights, it can be decided if recovery actions are necessary or if the conventional overcapacity recover the system's state in an acceptable amount of time.

To conclude, the tool supports the barge planner in the decision making process through providing an overview of the expected costs and duration of recovery actions and whether or not these are feasible. It does not provide the barge planner with an optimal solution.

Detection of exceeding extra barge capacity

As discussed in Section 5-2, there is currently no detection of smaller disruptions together exceeding the extra transport capacity Alpherium sails with. Based on conversations with the barge planner, this extra capacity was estimated on two trips, or 180 TEU. Thus any disruption with an impact less than 180 TEU can be absorbed through the extra capacity, and thanks to the flexible barge planning does not form a risk to CA t-0 or CA t-3.

But as stated earlier, if multiple smaller disruptions lead to a loss of transport capacity higher than the average overcapacity, the disruptions are being absorbed through using the transport capacity for safety stock replenishment. Left over capacity will be used for transport of containers specifically required in order to attain CA t-0. Thus the safety stock will not be replenished, which is not noticeable throughout the process, since the cross-docking of production will not be at risk. However, the vulnerability of the chain will increase, which means a new disruption could have a bigger impact on the CA then when the operation is in its desired state.

As part of the Excel-file which includes the disruption impact model and the decision support, a form was included that supports registering all disruptions to the transport capacity. Where a disruption stands for an unwanted deviation of the barge planning. The barge planner can register all disruptions in the same way as the disruption impact model, however here it is not the TMA that will be estimated but the missed number of trips. This way, the barge planner gets notified when the disruptions together resulted in a loss of over two trips. The reason we chose to use the quantity of trips, is because the barge planner expresses himself in trips, and because it is an easy way to add the different types of disruptions and come to a rough estimation of the total impact, without having to fill in variables other that the disruption. The impacts of the different type of disruptions are incorporated as follows:

- Sailing with two instead of three container layers = number of disruptions/3 (trips)
- Loss of a trip = number of disruptions (trips)
- Non sailing hours = amount of hours/32 hours (trips)

  - Assuming that all barge plans exists of at least one trip to Rotterdam
- Added sailing hours = Non sailing hours
  - Assuming that all barge planning exists of at least one trip to Rotterdam
  - In Appendix F it was stated that only if a detour has to be taken for the entire week, it can be incorporated into the average trip time of a barge. If this is not the case, the added trip time should be treated equally as non-sailing hours. In the case of the detection file the barge planner considers the disruption impacts per day, and therefore should treat the impact as non-sailing hours.

An accompanying advantage of the use of the excel file, is that the registration of disruptions is supported. This way when discussing certain events or performances, the file can be used as a source of historic data.

7-2 Evaluation of disruption impact model and detection file

In order to gain an insight in the usability and impact of the tool, an evaluation took place. The first step of the evaluation phase, was to see if the outcome of the disruption impact model showed realistic outcomes.

Average trip times

In order to do so we first looked into the average trip times as important input variable for calculating the TMA, and evaluated if these were close to accurate. To do this, we evaluated four weeks where we compared the outcome of the TMA calculations with the reality. We did this for week 7 up to and including week 11. In consultation with the barge planner the following possible trip times were compared.

Table 7-3: caption here

Possible trip times		
	Rdam	Antw
1	19	30
2	28	44
4	32	48
5	36	52

With the ‘what if analysis’ in Excel, we compared the outcomes of the different trip times. This was done through first comparing the outcome of that week’s calculated TMA based on that week’s barge planning of Friday to the supply of empty containers in reality. The real data was retrieved through modality software, that keeps track of in- and outgoing container traffic at the inland terminal. To compare the different trip times, we searched for the trip times that gave the smallest difference in trip times between calculated TMA and actual empty container supply. The outcome showed that the smallest difference was retrieved through using the trip times of 28 and 44 hours. After consultation with the barge planner, this was considered realistic. Thus, the model should incorporate the average trip time of 28 hours for Rotterdam and 44 hours for Antwerp. A validation over a longer period could have given different outcomes. It should be kept in mind that it is still an estimation which can deviate from reality.

Validation of the disruption impact model

To validate the disruption impact model, we can perform a similar action as to evaluate the average trip times. Again we compare the outcomes of the TMA-calculation with the empty container supply in reality. The weeks that were evaluated are week 13 up to and including 17 and week 26 up to and including week 33. The TMA-calculation were based upon the Wednesday versions of the barge plans of those weeks. Unfortunately, due to a lack of clear registration of disruptions and/or adaptations to the barge planning, events during the week were difficult to include in the calculation of TMA. Information exists about what kind of disruption would occur and when, but not for how long and when, how or if it was solved, does it provide complete information about adaptations to the barge planning. Therefore, we chose to only compare those weeks that did not include any events that deviated from normal operations. The outcomes are shown in Appendix H. Apart from the weeks 13 and 28, the differences are considered acceptable. Due to planning restrictions and possible adaptations, an exact equal number is not realistic. But over four, five or six barges, differences between 0 and 180 TEU are considered acceptable. This means the difference is less than half a trip per barge over a whole week. Thus it can be concluded that the outcome of the TMA calculation is comparable to reality. Unfortunately, we were not able to validate the calculation of the impact of a disruption due to the lack of clear and detailed information about the different disruptions. It is assumed that by calculating the impact of a disruption with the tool directly during or after a disruption a realistic indication of the impact can be calculated, as it is based on real-time information.

Including and extracting extra capacity

As earlier stated, Alpherium sails with an extra transport capacity of approximately 2 trips. This means that recovery actions do not need to recover this part of the disruption's impact. In order to incorporate this into the tool, the following was decided:

The use of the detection registration is the first step of the tool, which should be taken every time a (minor) disruption occurs. If the sum of all disruptions do not exceed the limit of the extra capacity, no further steps are required.

If it does exceed the limit, the barge planner will have to fill in the disruption impact model in order to calculate an estimation of the impact of the disruption on the transport capacity (in TEU). The outcome of this calculation will arise at the third step of the tool which is decision support. The input in the form of the estimation of disruption impact in TEU, is given with extraction of the extra capacity. This way recovery actions are only targeted at the lost capacity which could harm the CA t-0 or CA t-3.

Final evaluation and use

After finalizing the tool, it was tested and discussed with the barge planner and terminal manager at Alpherium and the team manager and loading planner of OS. During these discussions it came to light that during the week, none of the operational parties lay any focus on the CA t-3. Nor would OS discuss CA t-3 at the beginning of that week. The reason for this is that for them, it does not matter whether a container is available one day, three days or 10 days early, as long as they receive it on time. So therefore they will not consider taking any recovering actions that help attain CA t-3, and solely focus on CA t-1 or CA t-0. For Alpherium, the focus lies on CA t-3 the moment the barge planning is made, to check if the barge planning is compatible to the loading plan and can provide 90% of the containers three days before the expected loading moment. Alpherium stated that, for them to take additional recovery actions to provide CA t-3 on target, they would have to make extra costs. With their usual extra capacity, they aim at slow but costless recovery of the safety stock, and thus the attainability of CA t-3's target. So even if smaller disruptions together harm the CA t-3, there is no trigger for either parties to come up with recovering actions. Besides harming the performances of CA t-3, it also adds a risk as one of the major mitigating actions is not functional during a certain period, leaving the process more vulnerable than desired and assumed by non-operational stakeholders.

How big the risk of increased vulnerability is, depends on known and unknown future events. To deal with these increase in vulnerability, a method was introduced that could help value the risk of this vulnerability and trigger the recovering actions. If the detection registration shows one or multiple disruptions exceeding the extra capacity slightly, they could use the table below to estimate the magnitude of the risk of vulnerability.

Alpherium	Score (1–5)		OS (loading planner)
Extra capacity (planned capacity–production)			Production plan – Rest capacity – Overtime
Weather expectations			Warehouse storage
Congestion terminals			Market stock
Average score			**Average score**
Joint average score			**Joint average score**

Figure 7-1: Scoring table of vulnerability risk

Table 7-1 can help provide both operational parties, Alpherium and OS to discuss and make an indication of the risk of added vulnerability through labelling expectations of future events or states of the parts of the system. The left column stands for the information Alpherium can gather, as it is part of their daily job to keep an eye on those indicators. The same accounts for OS and the indicators listed in the right column. The information is always available as most of it is required for barge and production planning.

- Extra capacity

Based on the barge planning and the production planning, Alpherium can indicate whether or not their extra capacity is higher or lower than average. High extra capacity would cause a low risk, as there is some capacity to absorb (parts of) a new disruption. Minimal capacity would therefore form a bigger risk.

- Weather expectations

Although uncertain, based on the weather forecast, Alpherium can state an expectation on whether or not they expect any natural hazards like strong winds or a storm. The expectation can also be partly based on the current season. E.g. a storm in summer is less likely than in fall or winter season.

- Congestion terminals

Heavenly congested terminals limit the handling capacities of the deep sea terminals and can cause delays. Congestion can take up numerous of days, and the aftermath could also hurt the operation as in some cases, the deep sea vessels will get priority over barges once the terminal operations are back to normal. Thus, current congestion at deep sea terminals increases the risk of added vulnerability.

- Production plan

The production plan shows the demand for empty containers. A higher demand could mean a higher risk as the capacity of warehouse for storing is limited and there is less transport capacity to spare.

- Rest Capacity

Rest capacity stands for the capacity of the production lines at the brewery. High rest capacity indicates a low production volume, and thus lower empty container demand.

- Overtime

The overtime stands for overtime of the employees of the brewery. Overtime indicates that the production volume is high, as it cannot be produced within labour hours.

- Warehouse storage

Current storage in warehouse can suddenly increase due to events within the brewery, and is therefore very uncertain. However, there are some indicators that can tell whether or not storage space will be more limited than average. Due to different legislations the first batch of new product innovations are stored at the warehouse. Another indicator would be that products are placed in quarantine, meaning they cannot leave the warehouse any time soon. The most common indicator is the production of conventional products, which is the non-export production that is stored before being loaded onto transport. A high conventional production results in less storage capacity for export products.

- Market stock

The market stock of overseas clients is only known by the team manager of OS, and usually does not increase or decrease the risk of added vulnerability. However according to the team manager, there are some cases where the market stock is slim, and a delay in transport production would have a higher impact than usual. In these cases, the team manager could state that the risk of added vulnerability is high, as the impact of a insufficient CA would harm the customer's market.

Because the states and events are uncertain, dynamic and complex quantifying, the risk of increasing vulnerability is extremely challenging. To overcome this, the expertise and experience of those involved is use to quantify the risks through giving a subjective indication of the risk by using a score between 1 and 5. This way, it can be made clear whether or not the added vulnerability should be a cause for concern. The output of the tool, including the estimated impact of the disruption and an indication of the expected costs per recovery action, combined with the output of Table 7-1 can support the decision making process on whether or not to implement recovering actions in order to decrease the process' vulnerability.

During the test phase of the overall tool it became clear that the costs of using extra truck capacity in comparison to adding barge capacity are very high. And in consultation with the loading planners and barge planner it was stated that the costs for truck capacity are too high in relation of the expected reward of decreasing vulnerability and thus replenishing the safety stock. Therefore it can be concluded that using extra truck capacity is only applicable to secure CA t-1 or CA t-0.

7-2-1 Limitations and use

There are a number of limitations to the developed decision support tool, that should be kept in mind when using it. First of all, considering both detection, as calculation of disruption impact and the decision support, all of these sub parts provide the user with a rough estimation. Therefore the tool should only be used as an indication of impact and expected costs. It is very important that during the use of the tool, the users still use their own expertise and insights in order to see if the indication reflects reality.

The tool does not combine a high level view (impact on transport capacity level) and a detail level view (impact per container colour and type), nor can it replace the detailed level view. The detailed view remains important as it tells the barge planner what containers to pick up. The high level view provides a quick insight on how many containers have been impacted and the required transport capacity to recover from it. In a way the tool provides information on the required capacity and the detailed level view provides the barge planner with information on how to use this capacity. Thus in order to improve the recovery step of disruption management, the tool and the current detection methods should be used hand in hand.

Considering the fact that the high costs for truck capacity are only accepted when recovering for CA t-1 and CA t-0, the decision support loses some of its usefulness as it cannot help support a decision about adding truck capacity in order to restore the safety stock. However, it does provide a quick insight into whether or not adding barge capacity would be worthwhile, and into the costs for truck transport if used to recover the CA t-1 or Ca t-0. It can be stated that the tool does show whether or not the impact of a disruptions asks for adding barge capacity and if so, how much and how long recovery will take.

Impact of the tool on inter-organizational collaboration performances

Besides addressing some of the gaps of the case study current SCRM and SC-disruption management, the tool should also address the gaps identified through analysing the inter-organizational collaboration performance indicators. During a discussion between the terminal manager, the barge planner, the sea freight contract manager and the team manager OS about the use of the tool, they were asked if they believed if the use of the tool could increase trust between both parties.

All parties agreed that by using the tool it could help increase the insight of HNS in the considerations and choices made by Alpherium after or during a disruption. It would also increase the frequency of sharing information, as all layers within the organization of HNS could be informed on the impact and the expected duration of recovery from a disruption. Such an increase of openness can help further develop trust and commitment within the collaboration (Barratt, 2004). Juttner et al. (2003) describes how openness is crucial for successful management of supply chain risks, and that being open about risk-related information indicates the presence of trust.

The use of structured registration of disruptions and the accompanying details was also considered by the barge planner as a useful tool. The quality of information can be improved through "encouraging more complete and frequent information flow" (S. Li & Lin, 2006).

Overall it can be stated that with the tool, through increasing the frequency of sharing information and improving information quality, the growth of trust between both parties can be supported.

Chapter 8

Adaptations to mitigating actions

A number of other identified gaps that were not addressed through development of the tool are addressed in this chapter. These are discussed separately as they only underwent minor adaptations. These adaptations are aimed at improving current mitigation actions in order to better manage the identified supply chain risks at Alpherium in collaboration with HNS.

8-1 Safety stock adaptations

As discussed in Section 5-1-4, the major limitation of the safety stock as determined by Alpherium is that it does not consider fluctuations in demand, because allocation of shipping lines is renewed every year. In order to gain an insight in demand fluctuations, we chose to take a step back and go from shipping line to country of destination. In order to identify demand trends per destination, we used volume data of the years 2012 up to and including 2014 for countries that have an annual demand around and over 400 containers, equal to the limit for safety stock. Currently demand is forecasted as an overall average of the forecast of 2015. So e.g. if the expected demand of 2015 was 1200, the daily demand would be estimated at (1200 containers)/(300 days)=4 containers per day. In order to find out if historic data can help improve the safety stock performances, the Mean Squared Error (MSE) was used to compare the outcomes of forecasting based upon historic data or forecasting as a result of a daily average.

The outcomes showed that for four different countries, the use of historic data would result in an outcome with a smaller MSE than the current method of daily average; Taiwan, Canada, The USA and The UK. These four countries represent over [redacted] of the overall volume produced in Zoeterwoude. Through incorporating the use of historic data in determining the safety stock, a distinction could be made between high and low season for demand. Since high season mostly overlaps the four countries with a reoccurring demand pattern, the result shows a higher safety stock during high season, approximately between April and October, and a slightly lower safety stock during the other months. These adaptations are expected to absorb peaks in demand during high season better. However, a close eye should be kept on strategic and tactical planning decisions as these can influence the container demand. The new method is described in more detail in Appendix I.

8-2 Contingency plan adaptations

Section 5-1-4 described how the current contingency plan was evaluated during the strike of January 2016 and seemed to be incomplete and resulted in friction between Alpherium and HNS afterwards. In order to address these two gaps, small adaptations to the current contingency plan were made. The first adaptation was the inclusion of information of the market stocks and product information, as well as the challenging deliveries. Both information flows are related to the export of loaded containers and are therefore not part of the scope of this report, however in order to understand the reasoning behind the inclusion of both information flows, a short explanation is given.

Challenging deliveries are deliveries that have a chance of missing the departure from the deep sea terminal. This can either be the result of delayed production, an insufficient CA or the unavailability of container transport to the deep sea terminals. The market stocks and product information comes from the MPB. The level of market stocks tells something about the need the different customers in the market have for a product supply. Product information can tell if the product is a general product or if it is a new product innovation. A new product means that there is no market stock and the introduction of this product is potentially announced for a specific date. Therefore, a delay in supply of a new product is considered to have more impact than delay of a general product with sufficient market stock.

Another adaptation was the alteration of the goal of the contingency plan. Prior the goal stated "determine measures and decisions when the forecast is that there will be no empty container supply from the deep sea ports for more than two days and/or if the stock empty containers hits a certain level and/or if there are no empty containers being supplied to the brewery with as a possible result downtime of one or more production lines". Besides it repeating the triggers for starting the contingency plan, the previous goal remained vague as it only stated to make decision and create measures but not what aim the decisions and measures should serve. Normally the goal of the process in general would be to cross-dock all production and to attain a perfect customer order, so no delays of loaded containers and no rescheduling. However, during the strike, it came to light that there is a shift in goals during a contingency situation which is not made clear in the non-adapted version of the contingency plan. The focus shifts to the prevention of down time of the production lines and depletion of the market stocks. In order to prevent extra costs being made to supply market stocks that were already saturated, the information on market stocks should be available in order to determine fitting decisions and measures. Thus the new goal of the contingency plan was made into "determine measures and define decisions to prevent unplanned downtime of production lines and depletion of market stocks". To provide more clarity an information flow scheme was added to the new version of the contingency plan, shown in Figure J-1 in Appendix J.

Another adaptation to the contingency plan would be using the outcome of the disruption effect model as an information input. It can provide all parties involved with information about the disruption, the impact and if adding barge capacity would be a feasible option, and if so, how long will it take for the system to be back to pre-disruption state.

8-3 Evaluation of adaptations

The adaptation of the safety stock takes place on a more strategic level and is not expected to have a lot of influence on the daily operations. Therefore, it is not assumed likely for it to influence the collaborative performances. The new safety stock was discussed with both parties and deemed useful.

The adaptation of the contingency plan was partly evaluated during the strike. The discussed information flows were added before the strike took place. This was possible as the strike was announced beforehand. Afterwards the adaptations were considered helpful by those involved.

The adaptation of the goal of the contingency plan was done afterwards, as a reaction to the friction between parties that arose after the strike. It is expected that the adaptation of the goal will support the collaborative performances. As stated in Section 2-2, a shared vision can contribute to an increase in information sharing and the quality of information sharing (S. Li & Lin, 2006). In the case of the contingency situation, the vision or goal was not clear and therefore interpreted differently by both parties. A difference in understanding can prevent meaningful information from being shared (L. Li, 2005).

Based on the outcomes of Chapter 6, Chapter 7 and 8, we aim to answer the final sub question. The outcome is discussed in Chapter 10.

Part III

Discussion, conclusion and recommendations

Chapter 9

Discussion

This chapter discusses the major findings of the research and attempts to determine the outcomes' values and general applicability to other collaborations between inland terminals and shippers. It also discuss the similarities and differences between the research outcomes and the theoretical framework discussed in Chapter 3 and aims to explain them. Aside from the discussion of results, this chapter also reflects on limitations of data used and the effects of the methodology on the process and outcomes of the research.

9-1 Discussion of results

In order to gain an insight into the differences and similarities between the structure of HNS in collaboration with Alpherium and structures of other collaborations between shipper and inland terminal, three other inland terminals were visited.

- Bossche Container Terminal (BCT)
  - Jeroen van Dijk, 12/04/2016

The BCT is the most similar to Alpherium in that it is linked to the Heineken brewery in Den Bosch. TTherefore the collaborative structure and critical objective are very similar However a striking differences between the two is the degree of structured information exchange. Based on conversations with the terminal manager at BCT and the departments at HNS, it was found that the perceived satisfaction of that collaboration was higher, as they had encountered fewer issues with the CA in during the collaboration. It was assumed that this is the result of the storage capacity at BCT in comparison to the storage capacity at Alpherium. The terminal manager at BCT stated that for the more common container colour and types, they had a storage capacity of approximately two weeks. Whereas Alpherium has a maximum capacity of 5 to 6 days.

- Inland Terminal Cuijk (ITC)

– Michel van Dijk, 23/11/2015

The ITC is located in Cuijk and is part of Van Berkel Logistics. They have a very different structure from Alpherium. With the exception of one of their shippers, the shipping lines are not 'forced' to use the shipper's assigned infrastructure and therefore carry the responsibility of empty container availability. Besides, not all of their shippers work with tenders so there is no possibility to keep an free safety stock for all their shippers throughout the year. They do, however, work with safety stocks in order to mitigate the risks of supply but the safety stock is a risk for the inland terminal as it influences their finances. In addition, not all shippers are fully dedicated, as they have the opportunity of working with another terminal as well. This results in less dependency between the shipper and inland terminal. For some shipping lines they function as an empty depot. Other important differences between ITC and Alpherium are the variety of shippers and the import/export balance: Alpherium has close to no import whereas the ITC has around 40% import.

- Markiezaat Container Terminal (MCT)
  – Richard Klaasen, 13/01/2016

The MCT is located in Bergen op Zoom. Wit respect to the structure, the MCT is more similar to the ITC than to Alpherium. A similarity is that the construction of the terminal came from one of the customers. A striking difference is that one of their major shippers has a dedicated shipping line, which results in a simpler construction. With respect to the location, MCT can pick up empty containers from other inland terminals besides the deep sea depots in Antwerp and Rotterdam. The terminal manager mentioned that they do not focus on barging as much as Alpherium and HNS. They follow a construction where, if the booking and closing data are less than four days apart, they automatically use truck transport.

Both terminal managers of the MCT and ITC stated that their shippers' products were not seasonal, making it easier to use historic data as a benchmark for forecasting demand. For both terminals the presence of other inland terminals means that can have more contingency arrangements.

The identification of risks and accompanying risk levels at an inland terminal

The supply risks can result in the unavailability of certain empty containers. Possible disruptions include a shipping line not having the containers available or a limited handling capacity at the deep sea terminals and depots. The deep sea ports remain a great source of uncertainty to the operations. This is considered the result of the uncertainty surrounding executing pre-determined barge rotations within the sea port of Rotterdam and Antwerp, the priority given to deep sea vessels and the domino effect of one delay throughout different terminals (Caris, Macharis, & Janssens, 2011; Douma et al., 2009). This is considered a serious issue among practitioners within the inland waterway transport field, and there have been a number of efforts to create a central organ to improve the coordination of different terminals and barge operators. However, the parties involved are not keen on sharing information and giving up a possible competitive advantage. Besides, it is a highly dynamic playing field which cannot be easily simulated (Douma et al., 2009). This means that all inland terminal operators deal with the supply risks that result from these uncertainties and pose a threat to the daily operations.

The supplier risks also reflect on the risks posed by the barge planning. The uncertainty of the handling appointments at the deep sea depots and terminals demands a barge planning that can cope with such uncertainty. Based on the analysis done in Appendix E and Section 5-1-2, it was found that the method of planning resembled a resilient approach (Walker et al., 2013) According to Walker et al., dealing with a high degree of uncertainty can best be done by using a robust approach. The resilient approach chosen by the barge planner at Alpherium contributes to the degree of supplier risk as the chances to performance losses are greater than with the robust approach (Walker et al., 2013). However, barge capacity is likely to be used more efficiently with a resilient approach during an uneventful week. But considering the supplier uncertainty as a result from the deep sea terminals dynamics, and based on desk research at the inland terminal Alpherium, such a week is considered highly unlikely. The risk of the barge planning is very case study specific; however the planning under high uncertainties applies to inland terminals in general.

When considering demand side risks, the case study analysis showed that forecast inaccuracies can result in a mismatch between demand and supply. In the literature, Wagner and Bode (2008) describe demand-side risks both as possible disruptions in the material flow to the customer as well as the "uncertainty surrounding the random demands of the customers". They also discuss forecast inaccuracies with a focus on the well-known bull-whip effect, a result of high volatilisation of demand and information distortions or lack of information sharing (Wagner & Bode, 2008). Chopra and Sodhi (2004) use the term forecasting as a way to define risks related to demand. They state that forecast inaccuracies are the result of "long lead times, seasonality, product variety, short life cycles, small customer base". They also consider information distortions due to "sales promotions, incentives, lack of supply-chain visibility and exaggeration of demand in times of product shortage". H. Christopher and Peck (2004) focus less on the demand uncertainties when defining demand side risks and state that every disruption between the focal organization and its market or customer can be considered as a demand side risk. Comparing the statements of Wagner and Bode (2008) and Chopra and Sodhi (2004) with the outcome of the SCRM-cycle steps for the case study, there appears to be a difference between the type of demand risks and forecast accuracies.

Demand for empty containers is created by HNS, and is the result of the production and planned departures from the deep sea terminals. Therefore, forecast inaccuracies of the detailed loading and production plan are relatively small. The main risk identified was the shift of loading moment within a week. Because we do not deal with a traditional supply chain partnership of manufacturer and customer when looking into the supply chain flows of the case study, it is assumed that this is the reason for deviation in demand-side risks and forecast inaccuracies compared to literature. The same goes for inland terminals in general. In a way, an inland terminal follows a make-to-order approach and therefore does not deal with same demand-side risks on an operational level as described in the literature.

On a more strategic level, the forecast inaccuracies can suffer from volatilisation of demand in number of containers. Consider the safety stock level, which is determined on the basis of the annual allocation. This annual allocation is based in turn upon forecasts made by MBP and is vulnerable to external market dynamics. If demand of certain international markets unexpectedly decreases or increases, the safety stock might suffer from chronic shortages or surpluses. Other inland terminals also work with safety stocks; however not all shippers have a similar structure to Heineken. Heineken as a shipper with high volumes has the position to 'force' the shipping lines to work according the inland terminal proposition and to use the inland terminal for storage. Apart from some other shippers like Ikea in Germany and Philips (Van den Berg & De Langen, 2015), who have a similar structure, other shippers do not have this possibility.

With respect the identified disruption risks, both external and internal, these mostly match the similar type of disruption risks as described in literature. The inland terminal can be considered as highly vulnerable to natural hazards. Strong winds and storms can shut down operations for safety reasons, while rail or road transport may remain safe. This is true for all inland terminals. Disruption risks in the form of an accident and route obstruction are assumed to be relatively low compared to e.g. road or rail transport.

Possible risk mitigating actions for an inland terminal

Before looking into the mitigating actions, it is very important to state that the choice for mitigating actions should follow the step of determining the system boundaries and the critical objective(s), associated targets and the identification of risks and risk levels. Before deciding, the assessed risk levels form the input for a trade-off decision, where decision makers have to weigh the costs of e.g. extra inventory against the probability and impact of running out of stock (Juttner et al., 2003). The critical objective influences this decision. For example, the case study critical objective is the container availability as the focus lies on cross-docking production and preventing production from going into the limited warehouse storage. Another shipper may also want to attain cross-docking but has more storage capacity, influencing the impact of having to store production.

Regarding the high supplier uncertainty, a safety stock is a common mitigating action at other inland terminals and frequently discussed in literature (Chopra & Sodhi, 2004; Kersten et al., 2007; J. V. Blackhurst et al., 2008; Zobel & Cook, 2008; Juttner et al., 2003; Zsidisin & Ritchie, 2008). However, as discussed above, a shipper such as Heineken is able to assign the inland terminal as extended storage of empty containers. The empty containers stock at Alpherium is free of charge, and in practice no limited standing time. This is not conventional, as shipping lines usually focus on a constant movement of their containers. However other inland terminals can be assigned as an extended gate (Veenstra et al., 2012) or have several shippers with relatively high volumes e.g. Campina and Mars in Cuyk or Ricoh in Bergen op Zoom.

The way the safety stock is determined at Alpherium deviates from a traditional safety stock as it takes into account the safety lead time of three days. The diversity of suppliers,the presence of the annual allocation and the planning processes makes this way of determining the safety stock specific to the case study. The storage capacity at Alpherium determines the limits of the safety stock. It was found that storage capacity is relatively low. Based on conversations with the inland terminal manager of BCT it was found that their safety stock is a lot higher. Naturally the higher the safety stock, the lower the vulnerability of the inland terminal to disruptions. Literature states that a high inventory results in financial risks (Chopra & Sodhi, 2004). However, the containers at Alpherium are a free inventory, without any detention fees and the container values are not likely do decrease over time. Therefore the higher the safety stock of containers, the better. A limited capacity could therefore decrease the impact of the mitigating action.

The extra barge capacity is a result of the deep uncertainty the barge planner has to deal with. The way the barge planning is carried out at Alpherium could limit the performances and satisfaction of the shippers and crew of the barges and has a more resilient than robust approach. Other inland terminals could choose to follow a more robust approach with their barge planning. However, it is assumed that the planning horizon of three days, limits the positive effects of a robust approach. Another option would be to create as many window slots as possible at the different depots. A window slot does not give security but it can diminish at least part of the effect of the short time horizon the planner can look into. In the case of Alpherium however, this is not possible as demand differs per week and if fixed windows slots are hardly used, they will be eliminated. It could however be applied to other inland terminals. The MCT has one shipper that requested the same handling appointments every week, meaning that this shipper could use fixed window slots for all their export during the year f. Ideally the uncertainty would be decreased due to an increase in collaboration and information sharing through establishing central coordination of port activities. However, as stated earlier, previous attempts have failed (Douma et al., 2009). Douma et al. (2009) propose "an information exchange based on waiting profiles" to decrease the number of planning deviations. Such a system could reduce uncertainty through increasing information exchange, giving the barge planner more accurate information to base his/her decisions on.

Disruption impact model

Behdani (2013) states that "the speed and accuracy of decision making, especially in disruption reaction and recovery steps are critical issues and have great impact on operational loss". He also states that delayed detection and a lack of information exchange can cause a delay in the decision-making process as part of the recovery or reaction step in SC-disruption management.

The disruption impact model was created to support the decision making of recovery steps after a disruption. As stated, through providing the barge planner and terminal manager with a quick insight into an estimate of lost transport capacity, the required recovery capacity can be quickly determined. In combination with the pre-defined contingency plan, reaction time can be limited resulting in a quicker recovery of the system's overall performances. Besides, providing insight into lost capacity for replenishment of the safety stock can support quicker restoration of the desired state. The developed tool also functions as a registering tool, supporting faster disruption detection through improved visibility. This contributes to a quicker start of reaction and recovery steps, and a limitation in the disruption's impact (Behdani, 2013).

Although the developed tool is very case study specific, the rationale behind it, is applicable to inland terminals in general, as visibility and information access support fast detection and limit reaction time. The support of viewing the impact on a higher level (transport capacity) in stead of only detailed level (container colour and type), is especially applicable to the case study as Alpherium deals with a high variation of suppliers. In addition, the registration method is based upon the fact Alpherium that sails with extra barge capacity, which might not be the case for other inland terminals.

Partnership performance improvement

The outcomes of the coding of stakeholder interviews and the similarities and differences with literature were already discussed in paragraph 5.3. The main inter-organizational collaboration challenge that was revealed through the stakeholder interviews was the lack of trust of HNS in Alpherium. This is considered problematic since literature underlines the role of inter-organizational trust in improving partnership performances and the sharing of information within a supply chain (S. Li & Lin, 2006; Wei et al., 2012). The developed tool aims at increasing the level of trust between the two partners by increasing openness and information availability and quality (Kwon & Suh, 2004; S. Li & Lin, 2006). On the basis of conversations with the other terminal managers, the relationship between HNS and Alpherium seems relatively intensive. It is assumed that this is the result of a combination of factors: for instance HNS is the major customer at Alpherium and the limited capacity at Alpherium, requires tight collaboration in order to manage risks and disruptions. Other reasons could be the limited storage capacity at HNS and the focus on barging. The terminal manager at Bergen op Zoom mentioned that at their terminal, a strict rule is applied: if a shipper does not have a minimum of four days between loading at the warehouse and closing time at the port, transport will be done by truck.The aim to barge adds a complication to the overall process in comparison to the one in Bergen op Zoom. Other terminals might follow a similar directive. However, trust remains important as a lack of trust can result in a partner spending too much time on figuring out their partner's "credibility and reliability " (Kwon & Suh, 2004). Trust also functions as an informal form of agreement to fill up possible gasps of the actual agreement and improves the chances of a long term successes (Cullen et al., 2000).

Although the tool is expected to increase the level of trust, the duration of partnership influences the amount of trust between partners as well. Insight into previous behaviours of one's partner can make the partner more predictable to the other. Over time, these insights grow and can either help increase or decrease trust in one's partner (Sahay, 2003; Kwon & Suh, 2004). This process relies heavily on information sharing as the information adds to gained insights (Sahay, 2003). As trust develops over time, long-term partnerships are more likely to create trust between partners unless one of the partners have given the other one a reason to do not trust them (Sahay, 2003; Kwon & Suh, 2004). Therefore it is assumed that partnerships that have a less intensive relationship and do not rely as strongly on a high degree of information exchange will be able to build trust over time.

9-2 Reflection and Limitations

This section describes the limitations of this research. The first part describes the limitations of the data used during this research, and how it could have affected the outcomes. The second part describes the limitations of the research itself, discussing assumptions and choices made during this research and how they may have affected the research process and outcomes. The sequence of placing the chapter on limitations before the conclusion was done deliberately in order to take into account these limitations, assumptions and their effect on the overall research when drawing the final conclusions.

9-2-1 Data

The case study used in this research was the main source of data for answering the research question. When this research was begun, the goal was to determine the impact of disruptions on the CA through historic data research. However, it turned out that limitations to the available historic data made this goal impossible to achieve.

One major limitation was that adaptations to the barge planning were not registered. Because adaptations are part of the everyday operation, this was a huge gap in available data. There were data available on the moment of arrival of containers, including colour, type, barge of arrival and terminal of origin. However, this information could often not be linked to the barge planning as the first version of this information often deviated considerably from the final version of barge planning information. This meant in practice that it was impossible to compare the barge planning with the actual outcome of empty container arrival.

Another limitation in the case study data was the way that disruptions were registered. There were in fact two ways to register disruptions: the trigger file and in the STAVAZA-mails. The limitation of the trigger file is that information on the disruption is limited. It is mainly used to appoint a responsible party, but is says nothing about disruption details e.g. duration. In addition, for a large part of 2015, the trigger file shows only the effect of the disruption on containers that would affect CA t-1 and CA t-0, but not the effect on CA t-2, CA t-3 or containers meant to replenish the safety stock. Therefore the total impact is not revealed. The limitation of the STAVAZA is that it provides very little information, as it highlights only one moment within a 24 hour period. For example, a STAVAZA email could state that a barge at one specific deep sea depot was waiting to be handled and was therefore running late. The next available information would then come 24 hours later stating that the barge was expected to arrive at Alpherium within an hour, but giving no details about what time the barge was eventually handled at the depot. The STAVAZA-emails could also not be compared to the barge planning as the barge planning adaptations are not registered. The CA-file was also not useful for determination of impact disruption as the CA-file is the result of the barge planning and does not show events that took place during the week. Another data source were the loading reports, compiled by the shipper of the barges. These contained information on what times barge would arrive and leave their destinations throughout the week. Unfortunately, not all loading reports were filled in completely, nor did they contain information about disruptions or causes of delay. In conclusion, data available at Alpherium was not suitable to determine possible impact of a disruption.

Subsequently, we looked into the data available at HNS and whether this information could help us to determine the impact of disruptions. The issue that we encountered here is the fact that, like the barge planning, the detailed loading and production plan is constantly updated. These updates can have several causes. It can either be deviations in production planning, or a reaction to an insufficient CA. Due to the monitoring processes between HNS and Alpherium, a disruption that has lead to the unavailability of a number of containers does not necessarily result in the impossibility of cross-docking of production and the storage of export products. Rescheduling could have prevented storing of export products or shutting down production when requested containers are expected not to be available. Thus, not all disruptions can be found through storage of export products. In addition, if we had looked at the amount of stored products, we would have been unable to determine whether storage was the result of an unavailable container or cause as this information is not registered at HNS. The same applies to trying to find a link between disruption and the degree of rescheduling necessitated by a variety of unspecified causes.

Because of the limitations to the use of historic data as detailed above, a decision was made to estimate the impact of disruptions based on the data available. This resulted in the disruption impact model, as discussed in Chapter 7, which uses the available historic data to validate these estimates. The lack of detailed information on disruptions remained a limitation, as it hindered the validation of the estimation. With little if any information about disruption details such as duration, an precise replica of the disruption could not be incorporated into the model which made the comparison of outcomes less valuable.

With respect to the determination of risk level per identified risk, the lack of disruption registration poses a limitation here as well. The trigger file used to determine the likelihoods does not provide information on disruption details. Therefore, it is uncertain whether a registered disruption is the effect of a prior disruption or was itself the main cause. For example, a barge delay could have been the result of congestion at a deep sea terminal, limited handling capacity at Alpherium or the optimistic barge planning. This cannot be determined based on the trigger file. Therefore the likelihoods could not be expressed in quantitative units. In addition, the presence of mitigating actions distorted the likelihood of disruptions. To deal with this limitation, the likelihoods were determined as relative to each other. This enabled the different risk levels to be determined, but offered a limited insight into the likelihood of the identified risks.

9-2-2 Research framework and methodology

The framework used for this research was fully adopted from Behdani (2013). Looking back, this framework is considered highly suitable to the aim of this research. It addresses all necessary steps in a logical order. Never during the research did the framework seem to skip a step or became vague. It also left sufficient room for the researcher's own input. The disadvantage of directly adopting a researcher's framework, however, is that we do not look at SCRM and SC-disruption from multiple views. Moreover, the framework is relatively new (2013) and not reviewed by many other researchers. However, the framework was still considered as valuable and reliable as it offered an extensive theoretical background and was reviewed by domain experts (Behdani, 2013).

The choice of the case study strongly influences the outcome of this research. Specific characteristics, as discussed in the previous paragraph, determine the answers to the sub questions about the identified risks, mitigating actions, the inter-organizational challenges and SC-disruption management. Subsequently the answers to these questions determine the answer to sub question 5 and the main research question. In order to prevent the outcomes of this research of only being applicable to the case study, a theoretical framework was used as the basis for answering the different sub question. The previous paragraph discusses the value of the outcomes with respect to the different types of inland terminals. During the research, three other inland terminals were visited; inland terminal Cuijk, Markiezaat container terminal in Bergen op Zoom and the Bossche container terminal in Den Bosch. These visits provided insight into the differences and similarities between these three terminals and Alpherium and supported the researcher in discussing the general applicability of certain research outcomes.

The case study focused on an inland terminal that planned trips to and from the port of Antwerp and Rotterdam, and therefore has a limited geographical focus. However, the port of Rotterdam and Antwerp are, respectively, the largest and the third largest port in Europe (of Rotterdam, 2014).

When considering the interview method in combination with the coding method, a more structured interview technique might, with hindsight, have provided outcomes that were easier to link to the theoretical concepts, concepts, although the reason not to use theoretical concepts. The reason to not use theoretical concepts within the questions posed, was to prevent receiving socially desired answers. For example, if we had asked a stakeholder whether they had trust in their partner, it was assumed unlikely that they would answer this question negatively.

The final outcomes of the inter-organizational challenges from the stakeholder interviews are very case specific. The method of coding is very sensitive to the researcher's interpretation. In order to prevent the outcomes from being too subjective, Section 5-3 compares the outcomes of the interview stakeholders with the theoretical framework introduced in Chapter 2.

IT-related risks are not included in this research. The reason for this is that there currently exists no technology infrastructure for communication besides regular email between Alpherium and HNS. Internal IT at both organizations can however form a risk. Internal at HNS relates to disruptions outside the scope of this research as it would concern a disruption within the office or the warehouse. Internal disruption at Alpherium would be part of the scope. However, they were not taken into account as they did not come up during desk research or the interview stakeholders. Besides, IT-disruptions are not expected to have an impact on barge transport and only on the shuttle service, which is outside the scope of this research.

Data from the case study was mainly retrieved through desk research. Fortunately, all stakeholders made time to discuss the research repeatedly and provided all information requested by the researcher without hesitation. The openness of different internal and external stakeholders made it possible to create a complete insight into the case study and the related processes. Incidentally, it was interesting to note that this research helped stakeholders increase their knowledge about the overall process as well. For example, many of the stakeholders involved had little to no understanding of the safety stock and its relationship to the safety time of CA t-3. Therefore the development of this research also contributed to the HNS stakeholders' general understanding of the barge planning.

Chapter 10

Conclusions and Recommendations

This chapter provides the final conclusions of this research by giving a brief answer per sub-question, and finally answering the main research question. The conclusions described have taken into account the discussion, limitations and effects of the used research framework methodology. After discussing the conclusions of this research, this chapter describes some final recommendations. The first recommendations are made solely for the case study subject; HNS and Alpherium. The second section lists a number of recommendations for inland terminals in general, and final recommendations for future research.

10-1 Conclusions

We discuss the answers to the sub-questions according to the order as described in Chapter 1, finalising this chapter by answering the main research question.

10-1-1 Answering the sub-questions

1 What are the possible supply chain risks to empty container availability at an inland terminal considering both information and material flows, and what are the related risk levels?

The highest risk likelihood can be paired to operational risks such as supply uncertainties, barge planning under high uncertainty, and forecast inaccuracies, all resulting in the unavailability of empty containers. These are considered as external operational risks, and can therefore not be internally fixed. The main cause of supply uncertainties, which also leads to planning uncertainties, is the way that barge rotations at the deep sea terminal are carried out. Due to the lack of central regulation and the relatively low priority of barge transport, the planned barge rotations suffer from the whimsicalities of the terminal operators and the limited planning horizon of three days (Douma et al., 2009). The forecast inaccuracies relate to the moment of loading, which is dependent on events within the brewery. This can result in loading moments being way ahead of schedule, and therefore before the requested empty container is available leading to storage of export products. Another common disruption is delayed arrival of barges, which can lead to multiple other risks, like limited terminal handling capacity (high likelihood), route obstruction (low likelihood) or an optimistic planning (high likelihood). The identified disruption risks have higher impact expectations but lower likelihood. The greatest likelihood of disruption risks are linked natural hazards. Barge transport and terminal handlings are assumed to be relatively vulnerable to conditions involving storm or strong winds as compared to rail and road transport.

The risks posed by the barge planning are highly case study specific, as they are the result of the method of planning at Alpherium. However, all inland terminals have to find a way to cope with the supply uncertainties as a result of the deep sea port dynamics. Demand-side risks are considered to have a relatively low impact because inland terminals are not concerned with the manufacture of products and are therefore unaffected by traditional demand risks such as the bull-whip effect.

2 What are possible mitigating actions that could address the identified supply chain risks?

When considering the fact that the highest risk levels can be directly linked to both the uncertainty of the empty container supply and to forecast inaccuracies, the main mitigating actions in the case study are the implementation of a safety stock combined with a safety lead time. The safety lead time is set for three days, meaning that empty containers should be available at Alpherium three days for the expected loading moment. The planning processes and lead times of the containers create barriers that make it impossible to manage this safety lead time. Therefore the safety stock is determined in a way that allows management of the safety lead time. The safety stock as determined at Alpherium serves two goals:

- When considering the barriers to managing the safety lead time, the safety stock is set to contain enough empty containers for the coming three days plus the average lead time per container colour and type. This way, the safety lead time of three days (CAt-3) can be managed according to its target.
- If supply of empty containers is disrupted, the safety stock can absorb (part of) the impact of the disruption and still secure the loading moment and thus cross-docking the outcome of production and preventing export products from going into storage.

Another mitigating action that addresses one of the more likely operational risks is sailing with extra transport capacity in the form of redundant barge capacity. Unpredictability and short term view caused by the dynamics of the deep sea terminals in Rotterdam and Antwerp often lead to highly uncertain barge planning. To deal with this the barge planner poses a flexible and resilient barge planning (Walker et al., 2013), that carries extra barge capacity in case delays or capacity constraints arise as a result of limited deep sea terminal handling capacities. In this way the impact of disruptions can be absorbed as unused transport capacity whilst meeting the demands by HNS and reaching the CA targets. A disadvantage to this approach is a lack of incentive for the shippers, and a resulting decrease in employee satisfaction (Locke & Latham, 2002).

Different monitoring processes facilitate the sharing of risk related information. Sharing of risk related information can be linked to the SC-disruption cycle. Accurate and timely information sharing can help the organization to discover situations that might be labelled as abnormal earlier, and therefore possible detect disruptions more quickly (Yang & Chen, 2007; S. Li & Lin, 2006; Lee & Whang, 2000; Behdani, 2013). Well-structured information exchange systems or agreements facilitate management of situations that deviate from normal and that are characterised by a high degree of uncertainty e.g. in the case of emerging risks, or a disruption, and help foresee container availability issues before the demand arises (Chen et al., 2010).

The choice of mitigating actions should be the result of decision makers weighing the costs against the expected impacts and the likelihood of the different identified risks (Juttner et al., 2003). The critical objective and its related target are important considerations in this decision making process. The case study focuses on cross-docking all export products. The limited storage capacity at the warehouse underlines the importance of this objective. The goal of barging all production as well as the limited storage capacity at Alpherium offers an extra complexity to the process in THIS case study. Other shippers might have for instance either more storage capacity themselves, or an inland terminal with more storage capacity or a more flexible policy with respect to the goal of barging.

The structure detailed in this case study, and the high production volumes of Heineken, offer Alpherium the opportunity of a safety stock that is free of either costs or detention fees. This is specific to the case study and, for most inland terminals not possible.

3. How can supply chain disruptions at an inland terminal with a focus on empty container availability be managed in order to limit the disruption impact?

IN order to manage supply chain disruptions, it is of great importance that, as part of the risk mitigation actions, the monitoring process is able to detect a situation where a risk results in an actual disruptive event. Quick detection of disruptions, can limit its actual impact as it can trigger an early of reaction and possible recovery steps (Sheffi & Rice Jr, 2005). Alpherium and OS use the CA-file to keep a close eye on the CA, in order to be as pro-active as possible.

Another way to limit the impact of a disruption is by having a pre-defined plan that limits the reaction time (Wagner & Bode, 2006). A contingency plan can be activated if the mitigating actions cannot prevent or absorb the impact of a disruption on the CA. A pre-defined plan should be clear and complete in order to have the desired effect. It is very important that all those involved in carrying out the contingency plan are aware of its aim, resulting in a shared goals and vision for all organizations. This further underlines the need for the exchange of the required information (De long & Fayeh, 2000).

Whether or not recovery is required depends on the degree of impact of the disruption. During this stage it is very important that the actors involved continuously monitor the disruption and gather information, as well as keep in close contact with the supply chain partners involved (Behdani, 2013). Therefore information about the impact should be made known to all those involved. Moreover it should be recognised that the quality of information about the impact influences the quality of the decisions made about recovery actions. So information about the impact should be as complete as possible. Focus on the loss of transport capacity as an impact of a disruption supports translation of the disruption impact throughout both organizations. It also offers a quick way to link impact to recovery actions, as the only way to recover from a disruption is to add transport capacity.

4 What are possible challenges from an inter-organizational perspective that could limit the partnership performances and information exchange between inland terminal and shipper?

To answer this question we analysed the collaboration and relationship between Alpherium and HNS. Overall, the well-structured information exchange, long term orientation and shared vision and goals seem to support the partnership performances as a result of the inter-organizational collaboration between HNS and Alpherium. However there were a number of factors that seemed to form a challenge to the collaboration.

- Timeliness of sharing information or a pro-active policy

Timely sharing of information, especially in times of high supplier uncertainty is considered very important by the interviewees of HNS. It is assumed that this could be linked to the stated importance of pro-activeness. In order to deal with supplier uncertainty and to secure performance during disruptions or in situations of high risks the partnership should follow a proactive policy.

- Credibility trust

The level of credibility trust, "trust in the ability of Alpherium to meet their obligations" was interpreted as low (Cullen et al., 2000). This had to do with a lack of insight of HNS in recovery decisions made by Alpherium and Alpherium's lack of timely information exchange in case of a disruption. The low level of credibility trust could decrease the perceived satisfaction and, through that, further decrease the overall degree of trust from HNS in Alpherium.

- Organizational culture differences

In general the partners show more cultural differences than similarities. Heineken considers itself to be a more professional and better structured organization compared to Alpherium. These cultural differences can form a challenge as it implies different methods and needs of information sharing and long term visions. However, it also seems to be an indicator for attitudinal commitment within this case study, as the 'prestige' of HNS, together with the high volumes involved, offer Alpherium a powerful position in the playing field of shipping lines and terminal operators. Analysis of the current contingency plan also showed that a lack of clear goal-setting could result in different visions and perceptions amongst the organizations, resulting in them having different interpretations of what the goal is.

- High staff turnover

It was found that a high staff turnover results in less experienced organization members which, in turn, could decrease internal organizational knowledge and result in a decrease of information quality and the awareness of the importance of information exchange (Yang & Chen, 2007).

The overall outcome of this sub-question is very case study specific. But the importance of trust is present within all collaborations. As a result of the characteristics of the collaboration and environment in the case study, the degree of interdependency between Alpherium and HNS is very high. This results in trust being of crucial importance (Kwon & Suh, 2004). Other inland terminals that collaborate with a variety of shippers may experience less of this dependency. However, a lack of trust limits the partnership performances and is therefore considered important for all partnerships. Since trust can also develop over time, as time decreases the behavioural uncertainties, the efforts that should be made to gain trust depend on the structure of the collaboration between inland terminal and shipper.

5 How can supply chain risk and disruption management be implemented in order to address these inter-organizational challenges?

With the case study it was found that there were a number of issues that should be carefully considered when implementing SCRM and SC-disruption management as a collaborative effort within a inter-organizational collaboration. Therefore, in order to adapt current SCRM and SC-disruption management in such a way that these challenges can be addressed, these issues need to be taken into account. It is also very important that adaptations govern a well thought-out and defined structure to offer a frequent and high quality information exchange that can support a quick decision making process as well as the growth of trust and perceived satisfaction. All this should be linked to a clear statement explaining the aim of different information exchanges to overcome organizational differences.

For the case study a tool was developed that took into account the support of a pro-active policy through improving the detection disruption step. It also offers a registration method that could offer a more structured and complete information source on disruptions. The same accounts for the disruption impact model, which is part of the tool. It is built in such a way that it is easily translatable to the organization of HNS and it offers an insight into the information on which recovery decisions are made. For all these adaptations to the current SCRM and SC-disruption management, a thorough consideration should be made between the costs (actual costs, but also time and effort) and the expected benefits. A renewed contingency plan offers a more complete pre-defined plan that can limit a disruption impact through decreasing the time of reaction and recovery steps. It also provides a clear aim.

Adaptations of the safety stock were aimed at preventing chronic shortages and surpluses of the safety stock by taking into account a low and high season. Although such improvements are mainly focused on improving current SCRM-management of the case study, better results in general can improve the relationship between the organizations. Behavioural uncertainty, as well as supplier uncertainty, could be decreased through partnership performance improvements, resulting in an increase of trust between partners (Kwon & Suh, 2004; S. Li & Lin, 2006).

10-1-2 Answering the main question

Combining the answers to the sub-questions provides us with the answer to the main research question. The final answer is described below.

The main research question related to the aim of this research is:

- *How can supply chain risks and disruptions with a focus on empty container availability be managed as part of the inter-organizational collaboration between an inland terminal and shipper taking into account the collaborative challenges?*

Supply chain risk and disruption management relies heavily on information exchange. The degree and quality of information exchange are influenced by inter-organizational characteristics that could support or counteract the partnership performances. Thus in order to support SCRM and SC-disruption as well as addressing with the inter-organizational challenges, quality and degree of information exchange should be part of the focus. Creating an open and well-structured support system for information exchange can contribute to this. Mitigating actions should be based upon a well-defined critical objective and related targets. This way the decision makers can carefully weigh the costs against the benefits and choose mitigating actions well-fitted to their system, keeping in mind their system limitations and possibilities. These and all steps within SCRM and SC-disruption should be a joint management effort in order to reduce information asymmetry and increase information exchange (Sodhi & Son, 2009). With respect to SC-disruption management, speed is also a crucial element, and this can can be supported through openness and visibility. Jointly monitoring as part of the SCRM-practices, increases information exchange and can help detect disruptions earlier. Such a pro-active policy can result in rapid detection leading to a quick system recovery and limitation of disruption impact. In order to achieve this, it is important to keep in mind cultural differences between organizations. Organizational culture can influence when, and how information is exchanged. Setting up pre-defined communication steps, and using a 'language' understandable for both organizations can help overcome such cultural differences. Cultural differences can also influence organization's goals and visions. Shared visions help organizations commit to each other and their goals. It is therefore very important to clearly identify the partnership's goal and visions to prevent misunderstandings.

This research aimed to identify and evaluate supply chain risks, possible mitigating actions and practices for SC-disruption management as part of a supply chain partnership between shipper and inland terminal. It also aimed to find a way to better manage these risks and disruptions as part of the partnership performance, by taking into account the social factors of an inter-organizational collaboration.

As a result of using a case study research, some of the answers to the research questions turned out to be very specific for the structure of the collaboration in the case study. The structure where the inland terminal offers as an extended storage facility for empty containers to the shipper is relatively uncommon and is possible due to to the high volumes of HNS as shipper. This study might therefore be mainly applicable to similar structures. However, the research did provide a general insight into the types of risk inland shippers deal with, and how SCRM and SC-disruption management should be a joint effort, with a well-structured information exchange support. Inland terminals and shippers can use these outcomes as a general directive when implementing or adapting their SCRM and SC-disruption management. This research also underlines the importance of taking into account relational characteristics and social factors and offers the main topics for consideration when doing so.

10-2 Recommendations

This sections discusses the recommendations that follow from the findings of this research. The first recommendations are specifically targeted at the case study. The second subsection lists a number of recommendations for inland terminals on collaborative SRCM and SC-disruption in general. Finally a number of recommendations for future research are given in the final subsection.

10-2-1 Case study

Based upon the current SCRM and SC-disruption management practices at the case study, a disruption impact model was created as part of a decision support tool. This model and its validation are described in Chapter 7. We recommend HNS and Alpherium to use this tool in order to register disruptions and improve the disruption detection step. It will also help them to provide an estimation of a disruption impact on a transport level, which can be directly translated into recovering actions. This should provide them with support on whether or not adding barge capacity is a feasible recovery action or if the impact could be absorbed through the general overcapacity. It is also recommended to implement the tool within the contingency plan and adapt the contingency plan as proposed in Chapter 8 and Appendix J.

Another recommendation to Alpherium is to take into account a low- and high season when determining part of their safety stock as described in Chapter 8. This way demand peaks and dips are considered and chronic surpluses and shortages are prevented.

The high staff-turnover and the value of expertise should be taken into account when a change of employees at HNS takes place. The departments CSE and OS have a relatively high staff turnover. It is recommended to HNS, that when they hire new staff at CSE or OS, the role and relation to Alpherium is explained to them in detail. A short visual presentation should help to achieve this. It would offer a method that does not take up a lot of time of the other employees, as the presentation will only have to be made once. The expertise and experience of a barge planner has a great influence on the performances of the process. Mistakes can directly impact the CA. It is therefore recommended to prevent a high staff turnover on this position, and to be sure that there are at least two employees capable of performing the barge planning to prevent holidays or sick leaves from impacting the system performances.

Team building activities should help strengthen the relationship between departments at HNS and Alpherium. As some of the employees at HNS are not very familiar with the operations behind the performances of Alpherium, it is recommended to let these employees visit Alpherium and that they are shown the daily operations and required steps.

This research assumed that as an effect of the method of barge planning, the lack of incentive could decrease the motivation and satisfaction of the barge crews. However, this effect has not been taking into account by the analysis as part of this research and its presence is therefore uncertain. A recommendation would be to discuss the method of barging planning with the barge crews in order to find out whether the assumption is indeed implacable to the case study. If this is indeed the case, follow-up steps are required, e.g. implementing a reward system.

Another recommendation is to look into possibilities of linking the information systems of both organizations. Currently communication is done through email, sending back and forth different files, or over the phone. It is assumed that linking the information systems, or parts of it, could decrease the chance of information distortions, and offers an improvement to the current information exchange structure. It would also increase openness, as both organizations have access to each other's systems.

More strategical recommendations would be to reconsider the planning process at HNS, and aim at providing a more continuous forecast. Another option that could help improve the performances is to increase the storage capacity at Alpherium. Current restrictions make these recommendations unrealistic, but the future might bring possibilities.

10-2-2 General

Recommendations to inland terminals and supply chain risk and disruption management in general can be derived from the final conclusion described in the previous section. When implementing or adapting SCRM and SC-disruption management, it is important to state a clear critical objective and related targets. Mitigating actions should be based upon these. It is also very important to keep in mind that SCRM and SC-disruption management should be a joint effort as part of the collaboration between inland terminal and shipper. Openness and structured information exchange are thereby of great importance to overcome inter-organizational differences. Another recommendation is the construction of a pre-defined contingency plan. This way the desired state of the system can be quicker restored through limiting reaction time.

Mitigating actions should predominantly be focused on dealing with supply uncertainties. Ways of decreasing these could be to set up a similar barge planning each week or to have as many fixed window slots as possible. But certain characteristics can limit these recommendations, which differs per inland terminal.

10-2-3 Future research

Future research at the case study should focus on the aim set by HNS and Alpherium to use only barge transport. It might be interesting to add road transport to the permanent transport capacity as a safety net for the container availability. Currently, when the CA forms a risk to the cross-docking of products, a recovery action is to add transport capacity. This added transport capacity is provided by an external party, who can maintain high prices due to a short time notice demands. Having a safety net of its own should limit vulnerability and dependency of external parties, which could make it financially interesting as well. Future research should help in finding out if the benefits would outweigh the costs, while taking into consideration the desire of HNS to become more environmental friendly.

To validate the conclusions of this research a case study should be performed at an inland terminal that works with a more common structure than Alpherium. Such a case study could involve an inland terminal with multiple shippers and a more balanced import-export distribution. This research should support or refute some of the findings of this report. The combination of the two would have an increased value to inland terminals in general.

A current inefficiency in inland water transport is the amount of empty containers transported back and forth. Research on the possibilities of collaborations between multiple shippers and inland terminals with the aim of linking import and export to each other, can find a way to limit these "useless" transportations. It is recommended to perform such research with the support of a shipping line. Shipping lines often aim at having their containers back to them as soon as possible and want to be constantly informed about the location of their containers. The linking of import to export could increase uncertainty about the whereabouts of their materials, but it could also decrease costs for the shipping line, presenting an incentive to collaborate.

Considering the dynamics in the ports, it might be interesting to find out if other nationalities are undertaking projects to insert a central organized planning or if they already use such a structure. This could function as an example to the port of Rotterdam and Antwerp.

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Appendix A

Sources of supply chain risk categorization

In this appendix we introduce the articles used as input for creating the final categorization of the potential disruptions identified in Section 2 Table A-1 provides an overview of the sources of risk as categorized in the articles and the related risks or examples of risks.

Table A-1: Sources of risk as described in literature

Article	Source	Risk
(Kleindorfer & Saad, 2005)	Operational contingencies	“Equipment malfunctions and systematic failures. Abrupt discontinuity of supply due to financial distress, and human-centred issues ranging from strikes to fraud’.
	Natural hazards like earthquakes, hurricanes and storms	Speaks for itself
	Terrorism and political instability	“Sabotage and destructive competitive acts and political instability”
(Sheffi & Rice Jr, 2005)	Random events	“including natural disasters”
	Accidents	
	Intentional disruptions	“such as job actions or acts of terrorism or sabotage”
(T. Wu et al., 2006)	Internal controllable	“refers to the internal risk factors that originate from sources that are most likely controllable by the company. Examples are the quality and cost of the product’.
	Internal partially controllable	“refers to the internal risk factors that originate from sources that are partially controllable by the company. For example, fire accident in the company’.
	Internal uncontrollable	“refers to the internal risk factors that originate from sources that are uncontrollable by the company”
	External controllable	“refers to the external risk factors that originate from sources that are most likely controllable by the supplier company. For example, selection of the next tier suppliers’.
	External partially controllable	“refers to the external risk factors that originate from sources that are partially controllable by the supplier company. For example, customer demand can be partially impacted by company’s promotion plan’.
	External uncontrollable	“refers to the external risk factors that originate from sources that are uncontrollable by the supplier company. Examples are nature disasters such as earthquake, tsunami’.
(Juttner et al., 2003)	Environmental risks	“any external uncertainties arising from the supply chain such as disruption caused by political, natural or social uncertainties’.
	Supply risks	“the uncertainty associated with supplier activities and in general supplier relationships”
	Demand risks	“any risk associated with the outbound logistics flows and product demand, which can be caused either by inbound disruptions or, e.g. by seasonality, volatility of fads, new product adoptions or short product life cycles’.

Table A-1: Continued table.

(Wagner & Bode, 2006)	Demand side risks	"result from disruptions emerging from downstream supply chain operations. These include, on the one hand disruptions in the physical distribution of products to the end-customer, usualy in transportation operations and the distribution network. On the other hand, demand side risks can originate from uncertainty caused by customer's unforeseeable demands'.
	Supply side risks	"risks associated with the upstream side of their supply chains. These include supplier business risks, production capacity constraints on the supply market, quality problems, and changes in technology and product design'.
	Regulatory, legal and bureaucratic risk	"refer to the legal enforceability and execution of supply chain-relevant laws and policies as well as the degree and frequency of changes in these laws and policies This includes the ability to obtain approvals necessary for supply chain design activities and supply chain operation'.
	Infrastructure risk	"includes disruptions that materialize from the infrastructure that a firm maintains for its supply chain operations. It includes socio-technical accidents such as equipment malfunctions, machine breakdowns, disruptions in the supply of electricity or water, UT failures or breakdowns, in addition to local human-centred issues ".
	Catastrophic risk	"This class subsumes pervasive events that, when they materialize, have a severe impact on the area of their occurrence. Such events can be epidemics or natural hazards, socio-political instability, civil unrest, and terrorist attacks'.
(C. Tang, 2006)	Operational risks	"referred to the inherent uncertainties such as uncertain customer demand, uncertain supply, and uncertain costs'.
	Disruption risks	"referred to the major disruptions caused by natural and man-made disasters such as earthquakes, floods, hurricanes, terrorist attacks, etc., or economic crises such as currency evaluation or strikes'.
(H. Christopher & Peck, 2004)	Supply risk (external)	"relates to potential or actual disturbances to the flow of product or information emanating from within the network, upstream of the local firm'.
	Process risk (internal)	"These are the sequences of value-adding and managerial activities undertaken by the firm. Process risk relates to disruptions to these processes'.
	Demand risk (external)	"relates to potential or actual disturbances to the flow of product, information, and in this instance cash emanating from within the network, between the focal firm and the market'.
	Control risk (internal)	"These are the assumptions, rules, systems and procedures that govern how an organization exerts control over the processes. Control risk is therefore the risk arising from the application or misapplication of these rules'.
	Environmental (external)	"These events may directly impact upon the focal firm or on those upstream or downstream, or indeed on the marketplace itself'.

Appendix B

VSM

The first part of this Appendix describes the information flows and relations to each other in detail. The second part elaborates on how data for the VSM was collected. The third and final part shows the detailed version of the VSM.

Table B-1 discussed the different information flows in detail. The flows are categorized according to type of transport.

B-1 Information flows

Table B-1: Information flows

Barge transport	
Tender: Annual allocation	The annual allocation contains the distribution of the number of containers expected to be exported per destination and shipping lines and per brewery (Zoeterwoude/Den Bosch). It functions as an input for the coming year's production and deliveries.
5-week forecast	The 5-week forecast is made by TSCP every week and send to Alpherium. Based on this forecast, Alpherium can decide on how many barges they need to use for the coming week(s).
Detailed loading and production plan	The detailed loading plan is made every Wednesday by OS and links the deliveries to the production plan. It contains information about when production is expected to be loaded into an empty container, the assigned container, and when it needs to be at the assigned deep sea terminal. It is called the detailed loading plan, as it contains information for the coming 10 days. On Thursday changes to deliveries and production plan lead to a final update of the detailed loading plan. Everyday events could lead to adaptations of the loading planning and therefore Alpherium receives daily updates.
Production plan	The production plan is made every Tuesday by TSCP. It contains information on how much they expect to produce the coming week, what products and when.
Deliveries	CSE prepares all deliveries for the coming week on a Tuesday. A delivery is basically a customer order, containing information about its destination, date of departure and assigned shipping lines. The assigned shipping line is roughly decided based upon the annual allocation.
Barge planning	The barge planning is based on the detailed loading plan, and contains information about how many barges will be sailing the coming week, where to and where from and which containers they will take back. The barge planning is flexible, as it has to react to daily events.
Terminal schedule	Although the terminal schedule is not information shared between stakeholders, the information influences the barge planning. Depending on opening hours, capacity and other appointments the barge planner, can make a so called handling appointment for his barges. Part of the handling appointments is the date and arrival time of the barge, including the amount of expected handlings. Handlings can be unloading loaded containers or loading empty containers.
Feedback on barge planning	After Alpherium received the detailed loading and production plan from OS, they make a barge planning that is most compatible with the loading plan. Before confirming this planning to OS, the barge planner sets the planning out to the shipping lines. The shipping lines should provide feedback on the barge planning before Thursday 11 o'clock. Through this feedback they can let the barge planner at Alpherium know if the requested containers can be made available for pick up at the requested depot or terminal. A positive feedback means no adaptations to the barge planning are required.
Feedback on detailed loading plan	After having received feedback on the barge planning by the shipping lines, Alpherium can provide OS with feedback on the detailed loading plan. This includes information about containers they will or will not be able to get in time for the cross-dock moment.
Safety stock	Based on the annual allocation as an outcome of the tender, Alpherium decides on a safety stock on a year basis. This subject will be discussed in more detail in Section 8

The shuttle service lies outside the scope of this research. In order to provide an overall overview, some of the information flows required for the shuttle service process are described as well. We only take into consideration the information flows required during operation and not planning.

Table B-2: caption here

Shuttle service	
Call	The moment an empty container is needed at the brewery, a call will be send to Alpherium. The call contains information about which specific container is requested. The moment the call arrives at Alpherium, an empty handler or reach stackers picks up the empty container from a stack (the driver knows which stack is the right one) and places it on a truck with an empty chassis. The truck can then leave the inland terminal and drive to Heineken. expected to be exported per destination and shipping lines and per brewery
Dock information	When the truck driver with the empty container arrives at the brewery, he/she receives information through an SMS about which of the 10 docks the container should be driven to. Arrived at the assigned truck, the truck driver can leave the empty container behind and pick up a loaded container if ready.
Stop	When a truck driver comes back with a loaded container from the brewery at Alpherium, he receives information about the assigned stop. This information tells the driver where the loaded container should be stacked. At the stop, the container can be picked up from the truck and placed at a stack below the cranes.

B-2 Data collection VSM

In order to identify and collect information about the duration of the different process steps, the first step was to time the different handlings performed at Alpherium. I have been timing the loading and unloading of containers from and on to the barge by the cranes with a stopwatch. I also timed the time the reach stacker and empty handler required to perform the required container handlings. Information about the duration of the shuttle service to and from Alpherium were received through desk research. The same accounts for the trip and roundtrip times of the barges.

After collecting all data, the total Value Stream Map was validated during a meeting with two loading planners from OS, the terminal manager and barge planner from Alpherium, a barge planner from Van Uden and a team leader distribution from the brewery in Zoeterwoude. The contract manager was present as well. During validation I was told that the loading times of the cranes were too short, and I had probably timed one of the fastest crane operators. Therefore we eventually choose to go with an average.

Figure B-1 and Figure B-2 show the detailed version of the VSM, divided into the import and export process, including the estimated process step times.

The blocks below represent process steps. The straight lines represent information flows that are exchanged manually. The jagged lines represent information flows that are exchanged automatically supported by the system. The smaller blocks represents a physical source of information.

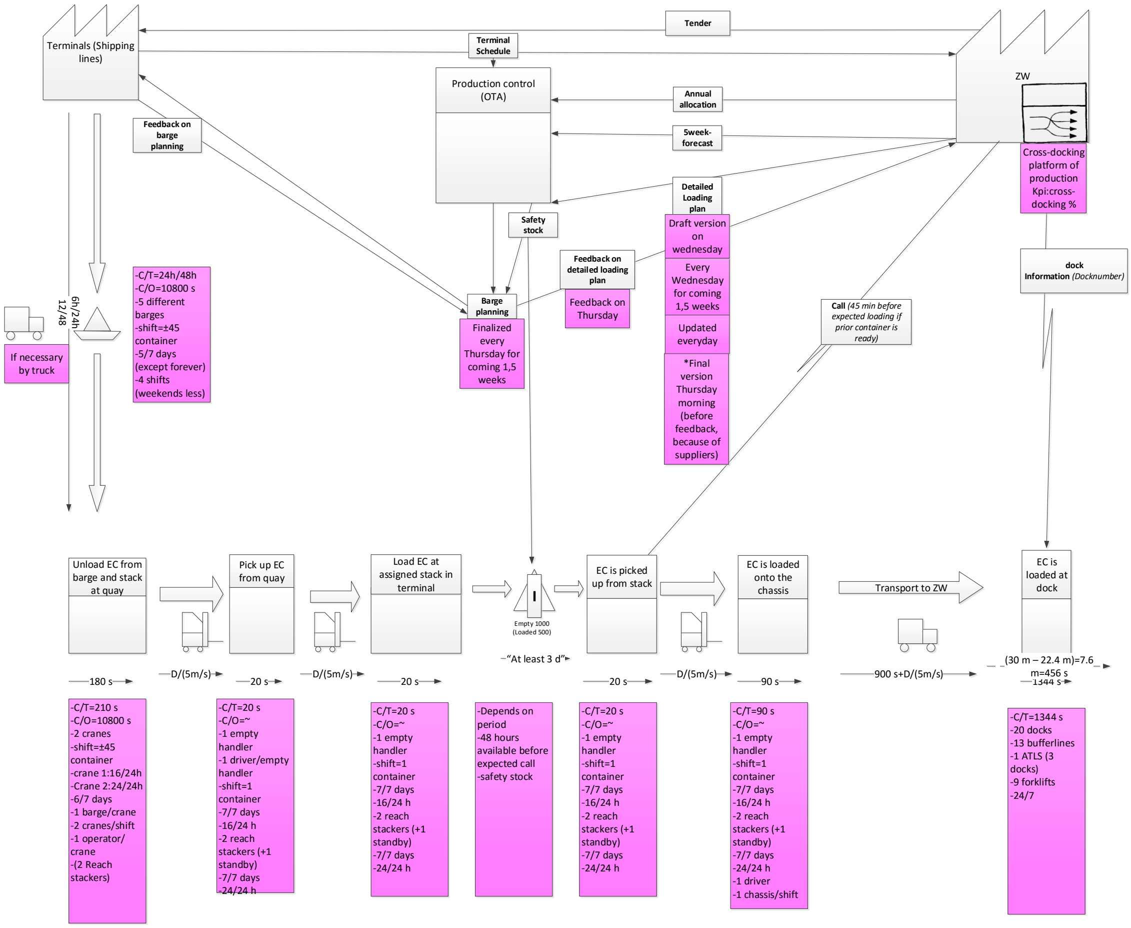

Figure B-1: Detailed VSM import process

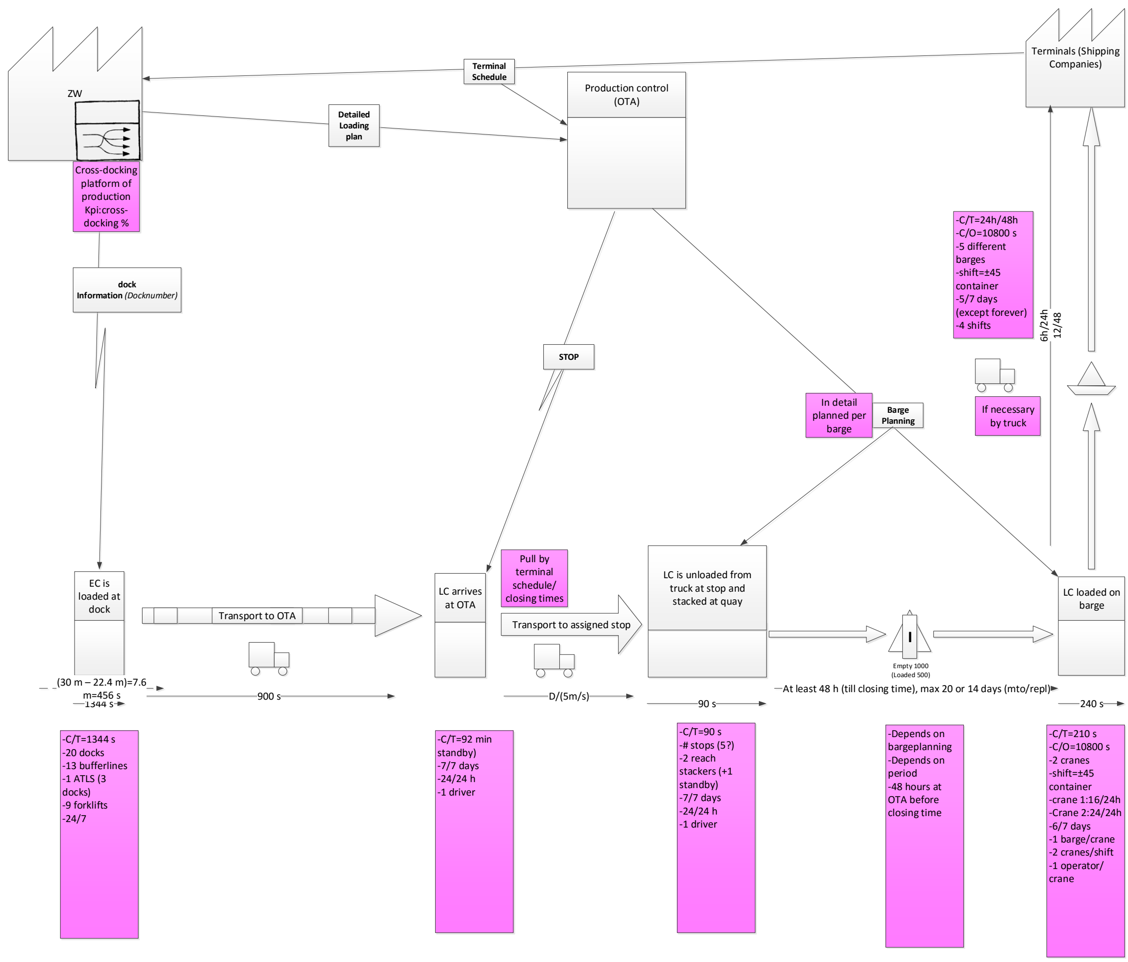

Figure B-2: Detailed VSM export process

Appendix C

Stakeholders interviews

C-1 The interview

De planning van productie en laden wordt bij Heineken elke dag gemaakt. Op woensdag wordt de meest uitgebreide planning gemaakt. Deze kijkt 1,5 week vooruit. Dit houdt dus in dat de forecast of de vooruitblik van productieplanning maximaal 1,5 week is. Binnen dit proces is uw rol van groot belang. Ik wil u hier graag een paar vragen over stellen. Ik zal deze vragen stellen volgens de STAR-methode, bekend van sollicitatie procedures.

Situatie, **T**aak, **A**ctiviteiten, **R**esultaat

Ik zal u vragen stellen over uw taak, activiteiten en resultaten tijdens de reguliere situatie en in situaties van nood.

Reguliere situatie

- Binnen de reguliere situatie, zoals hierboven beschreven, wat is de taak van u en uw organisatie?
- Welke informatie ontvangt en deelt u en met wie in de reguliere situatie?
- Welke activiteiten verricht u en uw organisatie, om het tot een goed resultaat te brengen?
- Hoe ziet een goed resultaat eruit in uw en uw organisaties ogen binnen dit proces? Welke belangen behartigt u hierbij?

Noodsituaties

- Welke risico's kunt uw benoemen die uw organisaties werkzaamheden binnen het beschreven proces kunnen beÃŕnvloeden? (Kunt u een voorbeeld noemen?)
- Welke effecten hebben deze risico's op uw organisaties taken binnen het proces? En hoe communiceert u deze? (Kunt u een voorbeeld noemen?)

- Welke activiteiten voeren jullie uit om deze risico's te beheren? (Kunt u een voorbeeld noemen?)
- Welke effecten hebben deze risico's op uw organisaties taken binnen het proces? En hoe communiceert u deze? (Kunt u een voorbeeld noemen?)
- Welke resultaten verwacht u van deze activiteiten?

Algemeen

- Kunt u de visie van uw organisatie beschrijven?
- Kunt u de missie van uw organisatie beschrijven?
- Kunt u de relatie tussen Heineken, OTA en de rederijen beschrijven?
- Welke rol spelen de terminals voor u in het proces?
- Kunt u de relatie tussen uw organisatie en de terminals beschrijven?

C-2 Example of transcript

Below is an example of a transcript form the interviews. This particular example is from the interview with the smaller shipping line. Two people were being interviewed. The other transcripts are send apart from the report and can be requested through the researcher, if deemed necessary.

Reguliere situatie

Binnen de reguliere situatie, zoals hierboven beschreven, wat is de taak van u en uw organisatie? **B:**Begint bij C, de operationele afdeling. Wij ontvangen van CSE de benodigde containeraanvraag, waar wij echt een boeking van gaan maken. Die informatie verwerken wij in onze computersystemen waaraan dan een uniek nummer gehangen wordt. Dat is per bestemming voor Heineken die wij varen, krijgen zij een referentienummer. Voor de hele boeking, dus niet per container. Per referentienummer, krijgt Heineken van ons ook een referentienummer. Dat kan de ene keer een container zijn maar een andere keer ook 17 of 5 containers. Daar hangen wij dan een nummer aan. Die dan bij ons bekend gaat staan, op de afdeling operationeel, alszijnde het boekingsnummer. Dat noemen wij dan het boekingsnummer waaronder de boeking bekend is, die voor een bepaald schip ingeboekt is en voor een bepaalde bestemming. Op dat moment stopt het weer op operationeel, want dat referentienummer heeft Heineken op een later tijdstip weer nodig om door te geven, in dit geval naar Alpherium. Waarna Alpherium naar de container controle afdeling komt met, he ik heb dit referentienummer van Heineken gekregen wat kunnen we gaan doen. Waar mag ik ze empty oppikken? **B:** En dan kijk ik meestal komen ze op woensdag al met die aanvraag en dan vragen ze of we donderdag voor 11en kunnen reageren dus dan hebben wij ook nog even tijd om uit te zoeken waar ik ze heb. En dan geef ik de depot door waar ze vrijgesteld kunnen worden. En wij doen uit ons systeem vandaan een vrijstelling sturen naar depot. Ook weer met dat unieke boekingsnummer. Dan geven we door dat het aantal containers wat nodig is, en dat het voor Heineken is. Want iedereen weet voor Heineken moeten we gewoon schone containers hebben. Dus daar wordt dan nog eventjes extra aandacht aan besteed. Dan wordt de boeking iig door de depot ook weer ingevoerd in hun systeem. Alpherium meld zich dan van joh we komen dit halen. Meestal halen ze de partij in een keer op, de andere keer halen ze de partij in delen op. Dat is verschillend. De afspraak maakt Alpherium met het depot, zij maken echt een laadafspraak van joh we komen morgenochtend om half 11 met die boot komen we zoveel containers ophalen. **C:** Wij zitten er niet meer tussen het depot en alpherium, die afspraken maken zij direct met elkaar. Wij geven een goedkeuring. **B:** Of er moet een situatie zijn dat het depot echt geen tijd heeft bijvoorbeeld. Dan kan het zijn, dat alpherium terug komt bij ons. En dan of stellen we ze ergens ander vrij of we bemiddelen toch even tussen Alpherium en het depot, van "kunnen jullie toch niet laden?" en dan kan het zijn dat het misschien nog een uurtje zal verschuiven en ze uiteindelijk toch kunnen laden. Met problemen doen we wel bemiddelen. **C:**Ja dan komen ze toch weer bij ons want dan zeggen ze joh jouw depot zegt dit en dat en dan moeten wij weer gaan bemiddelen.

Welke informatie ontvangt en deelt u en met wie in de reguliere situatie?

Recap: Jullie ontvangen een aanvraag vanuit CSE. Daar hangen jullie een boekingsnummer aan en deze geven jullie weer terug aan CSE en hun delivery wordt gekoppeld aan het referentienummer van de Rederij. En dat geven zij weer aan alpherium. Zodat die op instructie van Heineken dat uit kunnen halen. En die koppelen dat terug naar de rederij, over waar ze die kunnen halen

C: We krijgen dagelijks de voorraden van de depots en we kunnen het ook in ons eigen systeem zien. En dat ligt het ook aan de boekingen van andere klanten natuurlijk. De ene week heb ik ze bij dat depot en de andere week bij een andere. Het is aan ons om dat wel een beetje in te delen waar voldoende beschikbaar is. Het kan te maken hebben met waar en voor wie ze daarvoor gebruikt zijn. Niet alle containers zijn geschikt voor Heineken dus het kan zeker zo zijn dat bepaalde containers er niet geschikt voor zijn dus die zullen dan niet gebruikt worden. Hier worden ze schoongemaakt alle fruit eruit. En dan zijn ze klaar om voor Heineken weer afgehaald te worden en te vullen met het bier. Via onze systemen zien we inkomende ladingen, want dat boeken weer de agentschappen wereldwijd. Die boeken dan weer ladingen naar Rotterdam wat wij naar de Carribean boeken, boeken zij dan weer naar Rotterdam. En dan zien wij dat vanzelf op loslijsten komen welke ladingen, voor welke ontvanger is, wat er in zit, hoeveel containers het zijn. En die lading gaat dan gelost worden bij dat desbetreffende loods of adres. En dan komt de container weer terug waar B aangeeft waar de container teruggebracht moet worden. Want we hebben meerdere depots en je moet dus op meerdere depots zorgen dat je je voorraad houdt en hij zorgt dus dat ze dan weer terugkomen op de plaats die hij voor ogen heeft en als dan Heineken de volgende dag zijn containers weer op komt halen, gaan die containers gewoon weer door. De delivery via HEINEKEN ontvangen we via mail, en al het contact met alpherium ook via de mail. Afspraken maken gaat over de mail.

Welke activiteiten verricht u en uw organisatie, om het tot een goed resultaat te brengen? **C:**Eigenlijk constant contact, goede contacten.

Hoe ziet een goed resultaat eruit in uw en uw organisaties ogen binnen dit proces? Welke belangen behartigt u hierbij?

C: Het goede resultaat in onze ogen is wanneer Heineken tevreden is, wanneer wij voor Heineken het proces niet vertragen. Als Heineken de boeking doet bij mij op dinsdag. Op woensdag de aanvraag bij B komt voor de containers uit te halen en een week later hebben wij de containers weer vol terug van Heineken omdat ze beladen zijn. Dat is voor ons een goed resultaat omdat de klant tevreden, draaien onze containers mooi, dat is voor ons een heel goed resultaat. Absoluut. Je wil eigenlijk je container constant onderweg hebben, vol. Want het is te duur om hem stil neer te zetten en er niks mee te doen. Want hij moet bewegen, absoluut anders brengt ie nooit meer op wat ie gekost heeft. **B:**Misschien is het in dat geval even uit te leggen waarom we die nor gebruiken? Op die manier krijgt de rederij ze weer op een aantrekkelijke manier in de laadhaven waar ze voor het fruit zijn. Reefers zijn wel kleiner, daar moet Heineken rekening mee houden in het proces. Maar ze krijgen een betere prijs dan gewoon voor ijzeren boxen. Heineken zou graag een ijzeren voorraad hebben van Shipping line X. Maar daar wil Shipping line X niet aan mee doen. Het type equipment is te duur, en het aantal dagen is te hoog. Het voordeel is compleet voor Heineken en niet voor de Rederij. Wij zijn een niche rederij, heel beperkt in onze voorraden. En daardoor kan je je afscheiden van de rest en dat geldt niet alleen voor Heineken maar ook voor onze andere klanten. En om dan zomaar op een terminal hele bergen containers stil te hebben staan, dat is gewoon niet werkbaar.

Noodsituaties

Een terminal die de containers niet heeft. We hebben wel eens de situatie gehad dat ze willen op donderdag weten waar de containers uitgehaald kunnen worden en die willen ze vaak al op vrijdag op komen halen. Van een krappe stock, weinig containers, gebeurt het vaak dat wij op vrijdag pas met een zeeschip inkomend containers kunnen lossen die dan ook al leeg zijn en eventueel beschikbaar voor Heineken maar dat is dan al een dag te laat. Dus als onze boot pas op vrijdag binnenkomt en gaat lossen dan kunnen de containers natuurlijk niet gelijk direct opgepikt worden. Die situatie hebben we wel al een paar keer gehad. Dan is het overleggen, tussen ons en alpherium. We hebben zelfs wel eens de situatie gehad dat ze echt zo dringend nodig waren dat we hebben getrucked ipv met de barge. Dat was ook omdat we niet genoeg voorraad hadden. En we hebben onlangs nog containers vrijgesteld in Antwerpen in plaats van Rotterdam want dan heeft de rederij op dat moment wel voldoende in Antwerpen staan. En dan gaan wij ook overleggen en voorstellen of we ze in Antwerpen op kunnen vrijstellen. Om dat toch maar op te lossen voor Heineken. En we hebben zelfs wel een keer gehad dat we geen NOR hadden, dat we een keer ijzeren containers hebben gedaan. Maar dat is echt bij hoge uitzondering. Dan zullen we het proces voor Heineken in ieder geval niet vertragen.

En bij een storm? En de terminal ligt stil?

C:Dan ligt de hele Rotterdamse haven stil, dan hebben ze niet alleen problemen met het proces van ons maar met iedereen. Hun boten kunnen dan zeg maar nergens meer aanmeren, dus dan praat je echt over een noodsituatie. Dan worden de terminals echt stilgelegd en dan kun je geen container niet uithalen. En als een terminal echt dicht is kun je m ook niet meer met de truck ophalen. Trucken regelen we zelf. Wij moeten voor onze kosten zorgen dat de containers bij de depot (ALPH), die door Heineken aangewezen zijn, terecht komen dus wij betalen dan ook het barge transport naar Alpherium toe. Dus wij hebben dan onze eigen contacten waarmee we het vervoer regelen. Wij betalen de transport naar Alpherium en terug is voor Heineken. Als een container vertraagd is en niet op tijd op de terminal staat, neemt Alpherium contact met ons op. Want zij krijgen door dat ze m niet uit kunnen halen bellen ze ons op. **B:**Of natuurlijk al een moment eerder. Op het moment dat ze komen vragen waar kan ik ze uithalen? Dan zeggen wij al van ja sorry maar kan dat ook nog even wachten want we hebben ze nog niet. Als zij dat dan niet kunnen omdat ze, ze eerder nodig hebben dan ga je kijken hoe je dat op gaat lossen. We hebben wel eens gehad, dat door vertraging, we Alpherium door moesten sturen naar een ander depot. Maar op dat moment gaat het wel zo mis dat Anette ons belt. Die vraagt of ze toch iets kunnen doen, dat ze toch al (met een deel) gaan draaien. En dan gaan wij er samen (B en C) mee aan de slag. Anette belt meestal mij er over en dan ga ik met B zitten. En hij gaat uitzoeken, is dat mogelijk, staan ze ergens en eigenlijk komen we daar altijd wel uit. Het is wel eens een stress situatie even, want je wilt natuurlijk allemaal zorgen dat Heineken zijn proces verder kan draaien. En dan gaan we het aan alle kanten zoeken en dan kunnen we pas later alpeherium geÃŕnformeerd hebben, van wij zijn er uit, het brandje is geblust. Je kunt ze daar halen. En soms moeten we daar terminals voor verzoeken langer open te blijven, dus verzoeken of mensen willen overwerken. Dus daarom gaat er ook tijd overheen. En daar betalen wij voor want wij hebben niet kunnen voldoen aan de vraag van Heineken. Op het moment dat dat wij hadden beloofd dat ze ze vrijdag hadden kunnen afhalen, en dat komt door iets waar je niks aan kan doen. **C:**Je doet alles wat binnen je mogelijkheden ligt om Heineken te laten doordraaien. Heeft ook veel te maken met de band die wij met Heineken hebben, want we hebben gewoon goed contact. Met de jongens van CSE en Anette belt regelmatig. En dat is gewoon goed, het is regelmatig en niet via de email en niet iemand die je niet kent of niet ziet. Het leeft gewoon meer.

Welke activiteiten voeren jullie uit om deze risico's te beheren?

Heel veel contact met alle partijen, elkaar constant op de hoogte houden. Omdat je weet wat je hebt staan en waar, weet je ook al vaak snel of je aan de vraag kan voldoen. We proberen wel pro-actief met boekingen om te gaan. Op het moment dat ik de boeking krijg, gaat deze het systeem in, en ziet B al deze vraag gaat er komen, dus kan hij er al pro-actief zien of er ergens een knel komt, er al op reageren. En dan zijn we gewoon vroeg, en zo hoort het ook wel te gaan. Er zijn geen verschillen tussen wat er wordt gevraagd en wat er uiteindelijke gevraagd wordt. **B:**Wij houden ook in de gaten wat het stock van Alpherium is, en dan als ze en container lang hebben staan, bijvoorbeeld vanwege een omhanger, vragen wij ook wel van waarom kunnen jullie niet die container gebruiken? Want die staat nog bij jou, al veel dagen. Wij krijgen iedere dag een overzicht van Alpherium welke containers van ons ze in hun voorraad hebben staan en welke status deze heeft. Vol/leeg. Dus wij zien daar wel eens een voorraad komen, dan vragen we daar naar. Daar zit B vol boven op, waardoor hij er ook mee kan assisteren van joh, waarom pak je niet die? Meestal over de mail, omdat er ook andere mensen meekijken. En dan bereik je meer mensen die dat ook willen weten. Ik stuur dat naar Jelle en mensen die bij hem zitten. Volgens mij mogen ze iets van binnen 40 dagen, het hele rondje gedaan hebben. Die afspraken zijn met Heineken. Alleen turnaround van de depot, binnen 40 dagen weer terug bij ons.

Kunt u de visie en missie van uw organisatie beschrijven?

C:Wij zijn de dedicated agent van onze carrier Shipping line X, die in Antwerpen zit. Een bijkantoortje. Wij zijn, een soort franchise. Wij zijn van Huden en Veder, maar wij dragen de naam Shipping line X, maar als agent van Shipping line X Antwerpen. Dus wij zijn geen Shipping line X. Wij zijn een tussenpersoon tussen de rederij en de klant, maar wij zijn dedicated aan Shipping line X dus kunnen geen andere containers inboeken. Alle lijnen van onze lijn Shipping line X, wereldwijd, behartigen wij. En voor Heineken hebben wij alleen onze niche gebieden dus de carribean en deeltje frenchs indies, . de missie en visie Antwerpen is in lijn met die van ons. Onze dienst gaat enorm snel, en voor fruit is dit heel belangrijk.

Dus we kunnen geen vertragingen in de transit naar de bestemming veroorloven.

Kunt u de relatie tussen Heineken, OTA en uw organisatie beschrijven?

C:Ik vind de relatie tussen onze operationele afdeling en CSE is gewoon goed. We pakken de telefoon, mailen elkaar. Als er niks aan de hand is, en anders nemen we contact op. Prettig contact, we voelen ons gelijkwaardig en vertrouwen elkaar. Je kan ook dingen zeggen. Als ik vind dat ik te laat de boekingen krijg of als ik vind dat ze wijzingen te laat doorgeven. Want ik kan uitleggen waarom dat voor ons een nadeel is. Kijk als zij een dag van tevoren containers eens een week doorschuiven terwijl mijn boot vandaag in belading ligt en ze geven mij gisteren dat door. Heeft dat consequenties voor het schip, planning van dat schip voor de terminal die zijn lading al klaar heeft staan. En als je daar allebei begrip voor hebt dan praat dat ook een stuk makkelijker en opener. Late wijzigingen gebeurt wel eens, ik kan me voorstellen dat ergen in het proces van Heineken iets mis gaat. Ik vraag dan aan Heineken waarom de container niet terug is, want dat zie ik dan. Want zij hebben een bepaalde dag waarop ze die container terug moeten leveren. En dan vraag ik het op de email, wat er aan de hand is. En dan krijg ik terug dat het niet gaat lukken en of ik m door kan zetten met de boot van volgende week. Krijgt Heineken een nieuw referentienummer van me, zodat de container met een andere boot weggaat. De laadlijst moet aangepast worden en de rederij gaat met minder containers weg, en zij hebben de container een week langer. Kan je geen maatregelen tegen nemen. Het enige wat je kan is begrip tonen naar elkaar toe. Ik begrijp dat er iets mis is gegaan in het proces, zij begrijpen de consequenties. Voor een boete of iets, is de band met Heineken te goed. Je hebt een jaar een afspraak met elkaar en daar gebeuren dingen in, zoals wij met stormen te maken of een depot die een container niet heeft. Wij bellen er achteraan als een container vertraging heeft. Zij weten dat pas als ik er om vraag. Ik denk dat CSE ook afhankelijk is van informatie van Alpherium of BCTN krijgen dat zij niet precies meer kunnen volgen dat die planning nog wel staat, zoals die zou moeten staan. Ik weet niet hoe dat intern bij Heineken werkt, hoe zij die opvolging doen naar anderhalve week vooruit, ons geÃŕnformeerd hebben en of ze na 7 dagen kijken of het nog wel volgens planning loopt. Onze relatie tot alpherium is goed, denk ik. Niet zo heel veel telefonisch contact. Ja wat we net al hadden gezegd, veel vrijstellingen gaan gewoon via de email en als dat loopt dan heb ik er verder geen omkijken naar en hun ook niet. Als het besteld is en ze kunnen gewoon een laadafspraak maken en ze kunnen laden zonder problemen dan heb je daar verder geen contact over eigenlijk. Maar het gebeurt wel eens dat je wel vragen ofzo heb, dan kan je altijd de telefoon pakken om meestal Jelle te bellen. Verder weet ik niet uit mijn hoofd wie daar zitten. We hebben ze nog niet gezien Onze wens is nog steeds om samen daar naar toe te gaan, maar door tijdgebrek is ons dat nog niet gelukt. Wat het kan gewoon, alpherium en Den Bosch. Ja, de mensen van Heineken hebben we wel gezien. Zij zijn er goed in dat ze soms wat dagen organiseren voor leveranciers. En dan worden wij ook uitgenodigd. Heel goed, dan zie je de mensen en geef je een hand.

Welke rol spelen de terminals voor u in het proces

C:Wij zijn de tussenpersoon voor Heineken en de terminals/depots. wij zeggen jullie mogen deze containers afgeven met de boeking. Maar niet welke moment.. dat maken van die afspraken staan wij buiten. Wij maken de afspraak met onze terminal, die containers worden ergens deze dagen afgehaald. De relatie met de terminal is goed, hele andere situatie daar zijn wij klant. Dus zij willen die band wel goed houden want anders gaan we naar een ander met ons hele pakketje. Dus die situatie is dat wij klant zijn. Normaal is iedereen klant bij ons en nu mogen wij klant zijn. Heel persoonlijke relatie, nog veel meer dan met Heineken. Dagelijks contact met deze mensen, totale interactie. Daar ga je langs, meetings dingen bespreken samen lunchen etc. dat leeft enorm. Het is voor ons een heel belangrijk iets, als zij niet performen gaan onze klanten klagen. Zij bieden hun service aan en wij betalen daarvoor. Wij zijn klant bij Alpherium, wij betalen hun rekening van Rotterdam naar alpherium toe. Ik zie dat wel meer als een dienstverlenend bedrijf. Het zit er een beetje tussenin. We werken samen om Heineken tevreden te houden en te bedienen. Minder te benoemen relatie als klant. Wij gebruiken alpherium op verzoek van Heineken. Het is eigenlijk een depot van Heineken. En wij moeten zorgen dat daar containers beschikbaar staan voor Heineken. Het is voor ons eigenlijk een tussenhub. Onze eigenlijke depots zijn in Rotterdam. Alpherium zit daar tussen voor Heineken.

C-3 Coding of transcripts

The first step of this part of the analysis is to identify and discuss the theory about partnership performance and information exchange in detail. The next step is to create a coding scheme based on literature. This has been done in the theoretical framework.

Each of the discussed aspects of inter-organizational information sharing and relational aspects are considered as codes. It is important to keep in mind that these aspects are not exclusive and are mostly related to each other. E.g. trust could increase openness which in its turn increases the quality or frequency of information exchange. Values were added to the codes in order to provide a more detailed insight. E.g. communication frequency was divided into high frequency and low frequency, governance structure in well-structured and ill-structured etc.

Parts of the interview transcripts are linked to these codes in order to create an insight in the presence or absence of these aspects within the partnership between HNS and Alpherium. As stated earlier, due to type of interviews conducted, the level of own interpretation is relatively high.

C-3-1 Results

Table C-1 shows the outcome of the coding of the interview transcripts. The column sources states for the number of different interviewees that discussed the issue, the column references relates to the number of quotes that were linked to a specific code. Frequent discussed aspects were goals and interests by both parties, the quality of information shared with a focus on timeliness, joint partnership management, perceived satisfaction from the collaboration and the governance of information exchange.

As can be seen two factors were added that did not came up in the theoretical analysis. Both staff turnover and pro-activeness were discussed multiple times or deemed important but did not fit in with any pre-defined code. All aspects could be linked to the interview transcripts.

Table C-1: Code frequency

Name	Sources	References
Communication frequency	0	0
High communication frequency	6	8
Low communication frequency	0	0
Environmental uncertainty	0	0
Customer uncertainty	0	0
High customer uncertainty	4	11
Low customer uncertainty	4	7
Supplier uncertainty	5	6
Information sharing governance	0	0
ill-structured	4	7
Well-structured	6	19
Inter-organizational relationship	0	0
Commitment	0	0
Attitudinal commitment	0	0
high attitudinal commitment	3	10
low attitudinal commitment	0	0
Calculative commitment	0	0
high calculative commitment	3	9
low calculative commitment	0	0
long-term relationship orientation	1	2
Fair play	4	5
Unfair play	1	2
Reciprocity	3	6
Trust in supply chain partner	0	0
Benevolent trust	0	0
high benevolent trust	4	6
low benevolent trust	1	2
Credibility trust or Behavioural uncertainty	0	0
High credibility trust	2	4
low credibility trust	5	12
Partner's reputation	0	0
negative partner reputation	0	0
positive partner reputation	0	0
Perceived satisfaction	0	0
high perceived satisfaction	6	22
low perceived satisfaction	5	8
Joint partnership management	1	1
Lack of joint partnership management	6	9
Presence of joint partnership management	6	41
Openness	3	6
high	5	10
low	2	2
Pro-activeness	6	27
Qaulity of information shared	0	0
Adequacy	1	2
high adequacy	4	12
low adequacy	2	3
Credibility	0	0
Information accuracy	4	10
Timeliness	7	20

Table C-1: Continued table

Name	Sources	References
Shared vision	0	0
Conflicting goals and interests	6	15
Organizational cultural differences	3	5
Organizational culture similarities	1	1
Partner assymetry	4	7
Shared goals and interests	7	21
Staff turnover related	2	2

The figures below show statements that were linked to specific codes and deemed important for the analysis of the inter-organizational collaboration characteristics.

First we consider the results of the aspect of communication frequency. The values added were high communication frequency and low communication frequency. The quotes that were linked to high communication frequency are listed below. The coverage percentage reflects on what part of the source is linked to the source. In general, this is only one or a couple of sentences and will lie between 0 and 2%. Overall the communication frequency is considered high for both parties. No complaints on the frequency were registered in any of the interviews.

Overall customer uncertainty is considered relatively high due to possible late adaptations to the planning, the discontinuity of the planning and the short-notice. Although the current customer uncertainty is perceived less high than before due to weekend shifts and more spread out production.

Supplier uncertainty is noticeable throughout the chain. The effect it has on the collaboration is not directly clear from the quotes described in the table. Thus as a source we use the literature used to construct the theoretical framework.

High communication frequency

HNS

<Internals\\[redacted]> - § 1 reference coded [0,12% Coverage]

Reference 1 - 0,12% Coverage

> Goed, ik spreek ze dagelijks.

<Internals\\[redacted]> - § 1 reference coded [0,54% Coverage]

Reference 1 - 0,54% Coverage

> Ik heb wel eens perioden gehad dat ik echt dagelijks met marnix er door heen ging om te weten waar de risico's liggen.

<Internals\\[redacted]> - § 1 reference coded [0,60% Coverage]

Reference 1 - 0,60% Coverage

Wat ik voornamelijk doe is gewoon gedurende elke dag het schakeloverleg met Alpherium voorzitten van de operatie

<Internals\\[redacted]> - § 2 references coded [1,89% Coverage]

Reference 1 - 1,01% Coverage

> Je spreekt elkaar minimaal een keer per dag, dat is 's ochtends met het schakeloverleg, in de drukke periode, met veel verstoringen spreek je mekaar soms drie of 4 keer per dag.

Reference 2 - 0,88% Coverage

> Over het algemeen twee of drie keer per dag om iets te vragen of informatie op te halen en die lijntjes, zijn heel erg kort en dat vind ik ook wel leuk.

Alpherium/Van Uden

<Internals\\[redacted]> - § 2 references coded [0,87% Coverage]

Reference 1 - 0,18% Coverage

> We houden daarbij nauwgezet contact met Heineken.

Reference 2 - 0,69% Coverage

> Meer communicatie tussen de partijen onderling, meer overleggen. Meerdere keren per dag, en ja veel intensievere bemoeienis met het werk wat normaal gesproken door Jelle zelf gewoon gedaan wordt.

<Internals\\[redacted]> - § 1 reference coded [0,89% Coverage]

Reference 1 - 0,89% Coverage

> Dan heb ik vanuit Heineken contact met Anette, alleen als het langer aanhoudt, dan hebben we dagelijks via mail contact en gaan we ook een keer per week even bij elkaar zitten.

Figure C-1: Communication frequency

Environmental uncertainties: Customer uncertainty

Low

HNS

<Internals\[redacted]> - § 1 reference coded [0,57% Coverage]

Reference 1 - 0,57% Coverage

we verwachten zoveel containers te doen, dit jaar met jullie. En dat is, op rederij equipment en terminal niveau in Rotterdam.

<Internals\\[redacted]> - § 2 references coded [1,57% Coverage]

Reference 1 - 1,15% Coverage

Met die restcapaciteit hier scheelt dat wel natuurlijk, aan het begin van het jaar was het veel schuiven en omhangen. Sinds een week of 4 is dat hier. Door middel van weggevallen vraag. Dus dat helpt ook wel mee.

Reference 2 - 0,42% Coverage

Die pieken zijn weggevallen door vijf ploegendiensten en dat weekend erbij.

Alpherium/Van Uden

<Internals\[redacted]> - § 3 references coded [0,77% Coverage]

Reference 1 - 0,39% Coverage

Die piek is er altijd wel geweest maar die is iets minder scherp geworden, hetzelfde geldt door de week heen.

Reference 2 - 0,31% Coverage

Nu zijn de getallen is meer steady. Soms had je een twee keer zo hoge piek als normaal.

Reference 3 - 0,07% Coverage

Dat gaat nu beter.

<Internals\[redacted]> - § 1 reference coded [0,96% Coverage]

Reference 1 - 0,96% Coverage

Vandaar ook dat we die structuur in het leven hebben geroepen dat we die informatie krijgen op woensdag voor volgende week, dat we dan precies weten hoe veel we nodig hebben en van welk type

High

HNS

<Internals\[redacted]> - § 1 reference coded [1,57% Coverage]

Reference 1 - 1,57% Coverage

Maar en daar zit een beetje het probleem, wij willen gewoon als Heineken, dat is ons voordeel, wij willen daar heel flexibel in zijn. dus we willen eigenlijk, als we morgen besluiten de productie van vrijdag naar voren te halen naar maandag en maandag duwen we naar achteren dan willen we zo die dozen kunnen pakken bij de OTA en de BCT zodat onze operatie daar geen last van heeft.

<Internals\[redacted]> - § 3 references coded [4,66% Coverage]

Reference 1 - 0,88% Coverage

Op het moment dat je daar gaat achterlopen en dus heel snel meer containers aan gaat vragen, zie je dus automatisch dat Alpherium achter de feiten aan gaat lopen.

Reference 2 - 2,01% Coverage

De eerste driekwart jaar, was de planning zodanig vol dat we elke keer over de week heenvielen en de planning continu aan het switchen was tussen Zoeterwoude en Den Bosch dat je productie ging runnen die in Den Bosch gepland naar Zoeterwoude verplaatst werd terwijl die containers door BCTN al waren uitgehaald en dan kreeg Alpherium vervolgens die containers niet meer.

Reference 3 - 1,77% Coverage

Alpherium/Van Uden

<Internals\[redacted]> - § 3 references coded [1,49% Coverage]

Reference 1 - 0,63% Coverage

In het begin hebben we heel veel replenishment gedaan en nu zie je gewoon veel meer naar markten die veel meer op de bal zitten dus die closings worden ook steeds belangrijker.

Reference 2 - 0,60% Coverage

Wat betreft productfluctuatie: Jelle: bijvoorbeeld een CMA die om de twee weken gaat, dus ene week wel productie en de andere week niks. Dat is echt een golfbeweging.

Figure C-2: Environmental uncertainties: customer uncertainty

Environmental uncertainties: Supplier uncertainty

HNS

<Internals\\[redacted]> - § 1 reference coded [0,78% Coverage]

Reference 1 - 0,78% Coverage

De ECT en andere stuwadoors die hebben het eigenlijk voor het zeggen dus die dauwen gewoon dingen door de strot heen van de rederijen, terwijl de relatie eigenlijk andersom zou moeten zijn.

<Internals\\[redacted]> - § 1 reference coded [0,19% Coverage]

Reference 1 - 0,19% Coverage

ook niet goed weet waar je aan toe bent.

<Internals\\[redacted]> - § 2 references coded [2,16% Coverage]

Reference 1 - 0,97% Coverage

En dan gebeurt het vaak dat zij niet op tijd voor elkaar krijgen om die boekingen terug te krijgen, bevestigingen. En het komt echt best vaak voor dat wij op dinsdag dan niet de gegevens hebben.

Reference 2 - 1,19% Coverage

De week ervoor, vorig jaar was er een van die FOBvervoerders met Seatrade en dat is echt een hele kleine vervoerder die heeft ook niet standaard containers klaar staan dus dat ging eigenlijk standaard mis, dan loopt het gewoon de loods in.

<Internals\\[redacted]> - § 1 reference coded [1,26% Coverage]

Reference 1 - 1,26% Coverage

Containerbeschikbaarheid blijft in eerste instantie altijd een probleem maar dat komt ook omdat je het pakket hebt veranderd van alleen maar Maersk en MSC en nu zitten er allemaal kleine soortjes bij die bij wat het een probleem is.

Alpherium/Van Uden

<Internals\\[redacted]> - § 1 reference coded [0,83% Coverage]

Reference 1 - 0,83% Coverage

Als die ons niet helpen of heel erg vertragen, als je schepe heel erg vertragen dan gaat je planning niet lopen zoals gepland. Daardoor ga je reizen missen, lege containers missen en dan kan je niet aan de verzoeken van Heineken doen.

Figure C-3: Environmental uncertainties: supplier uncertainty

Appendix D

Identifying the supply chain risks

For identifying the different supply chain risks, different sources of data were used. These different sources, and their outcomes are discussed below.

– *Stakeholder interviews*

During the interviews, all stakeholders were asked to identify what, according to them, were risks to the process. The outcomes can be found in the transcripts of the interviews. Most interviewees identified external factors as extreme weather conditions or route obstructions, as trouble with a specific bridge. Other risks that where mentioned by multiple interviewees were congestion at the deep sea terminals and the chance on labour strikes, and equipment malfunctions. Some risks were only named by one interviewee.

One of the interviewees, who worked at the CSE-department, stated that the optimization for efficiency at Alpherium could form a risk for the overall process. But this was mainly targeted at the export of loaded containers and therefore not a risk to the critical objective or within the system of study. This interviewee also gave an example of extraordinary incidents like private incidents with a shipper or accidents with containers. The interviewees at Alpherium and one of the shipping lines mentioned the unavailability of containers at the shipping line. The warehouse team leader had a specific example on containers that were not placed at the night stack (Alpherium can only work with one assigned container stack during night hours by order of the municipality), and could therefore not be picked up if the brewery was running at night.

Striking was that only three of the interviewees discussed the information flows as a source of risk, while all the others predominantly focussed on the material flows within the process. The timeliness of information was discussed by two of the interviewees of HNS. They stated that in order for the process to run smoothly, it was very important that vital information was shared timely, if not it could form a risk to the process. The loading planner at OS mentioned the shift in weeks as a major risk to the process and the container availability in particular. He mentioned both the risks of inaccuracies within the information as well as the limited time Alpherium had to cater the demand that was known relatively late and could also have late adaptations.

One of the shipping lines was very opinionated about the limitations that Alpherium had as an inland terminal, and named this the major risk to the overall process. He stated that both the limited capacity for buffer stock as well as the limited sailing route to Alpherium formed great risks in his opinion. He also stated that the structure they used in their collaboration with Alpherium, where a deep sea terminal was used as a depot for Heineken, where Alpherium can pick up containers, came with risks as a deep sea terminal is not focused on barging, nor is it focused on handling empty containers, which therefore does not receive the same attention as when located at an assigned empty depot.

So based on the interviews we can identify the following risks:

- Extreme weather conditions
- Labour strikes
- Congestion at terminals
- Equipment malfunctions
- Accidents
- Route obstructions (bridges)
- Demand uncertainties (information delay and inaccuracy)
- Limited capacity

– Literature research.

Another way of identifying potential risks to (part) of the supply chain is through literature research. Chapter 2 discusses the outcomes of literature research and elaborated on terms and steps of SCRM and the different sources of risk, part of the outcome is described in Appendix A. These outcomes provide foundation for the outcomes of other ways of data collection.

– Trigger file

Another source of information is the file called ‘trigger file CA’. This file is used to register the causes of an insufficient CA and is sent to OS by Alpherium every day. It is important to mention that the trigger file is used to register foreseen issues with the CA, and does not say anything about how many times a container was not available when requested. The file consists of the following risks.

Table D-1: Explanation of triggers

Trigger	Explanation
Shipping line has no containers	
New delivery Heineken	This trigger refers to an adaptation of the loading plan that consists of a new container demand that has not been on the final loading planning discussed on Thursday.
Depot does not have time	
Delay barge	
Planning HNS more than 48 hours ahead	Due to events inside the brewery, production can be ahead of schedule. If the amount of time production is ahead on schedule is very high, the required container might not be available at Alpherium yet.
Prio containers have priority over others	Due to the certain circumstances, a specific container demand might have a higher priority than others, e.g. when the closing time might be in danger. This trigger could result in harming the availability of the non-prio containers. However, this trigger cannot be directly linked to a source of risk as it is an effect of an earlier disruption, since not both requested containers could be made available on time.
Handling capacity Alpherium	Limited terminal handling capacity at Alpherium.
DHL freetime	DHL freetime refers to containers that are not part of the regular process. In such a case container transport to Alpherium is the responsibility of an external party, which works with shorter free time than the shipping lines. This means that Alpherium is not allowed to have the containers at their terminal the same time before the expected loading moment as regular containers.
The shipping line does not provide feedback on time.	If the shipping line does not provide their feedback considering the availability of the empty containers before the barge planner can finalize the barge planning, the barge planning could become unrealistic.
Delay at deep sea depot/terminal	
(none)	Unknown
Weather	
Rejection containers Alpherium	If containers do not meet the required standard they cannot be used for loading Heineken production.
Containers for another delivery handed to Alpherium.	This trigger is also an effect of an earlier disruption and results in the unavailability of material.
Delivery not planned Alpherium.	A mistake was made by the barge planner.
Terminal does not have enough containers when barge arrives.	
Pick up reference unknown	If the pick-up reference is unknown, the shipping line did not perform all required activities. It can be therefore be linked to a human error.
Incorrect data in the planning system of HNS.	

– STAVAZA

Other information used for the identification of potential disruptions was found in in old STAVAZA-emails containing information about the progress of the barge trips and causes for delays or other issues. A number of these emails were used as input for this research. No risks were found, that were not discussed during the interviews, literature research or were part of the trigger file.

– Desk research

During the research, the planning process of the barges was observed and discussed thoroughly with the barge planner at Alpherium. The outcome of this process was the identification of one of the major operational risks: barge planning under high uncertainty.

It can be stated that a great amount of risks was identified. In order to provide a clear overview of these risks, we re-evaluated the identified risks in order to match similar risks or place them within a higher level category. This has led to the following risks.

- **Limited handling capacity Alpherium/deep sea terminal or depot**
  A limited handling capacity can be a risk, as it can delay a handling appointment or could make it impossible to get a handling appointment at one of the terminals. It could be the result of a congestion, an intentional disruption like a strike or malfunctioning of equipment. E.g. if one of three cranes would be down, it decreases the handling capacity at a terminal.
- **Container delay**
  A container delay is a risk that could arise at Alpherium. It can be the result of other risks. E.g. when a crane is down at a barge cannot be handled, it could happen that the container is not unloaded from the barge in time for the cross-dock moment. This risk is outside the scope of this research, considering the fact that containers arrived at Alpherium are seen as part of the CA.
- **Accidents**
  Accidents could harm the terminal capacity, e.g. if an accident happens with a crane or reach stacker. It could also arise during the trip, with the barge or with an employee. Results of an accident could directly or indirectly impact the CA, e.g. to a sunken container or a barge delay.
- **Intentional disruptions**
  Intentional disruptions can be labour strikes or terrorist attacks. These can result in limited terminal handling capacity or other impacts like route obstructions.
- **Barge delay**
  A barge delay is a risk as it can result in a number of containers being late for the cross-dock moment or a barge missing its handling appointment. A barge delay is assumed to be the effect of another source of risk e.g. strong winds or temporarily route obstructions.

- **Route obstruction**
  In general, a route obstruction arises at bridges. It can either be the main source of a risk but can also be the result of another risk, e.g. accidents or a barge delayed that misses a bridge opening.

- **Natural hazards**
  Natural hazards can refer to storms, earthquakes etc.

- **Forecast inaccuracies** Forecast inaccuracies are the result of demand uncertainties. Adaptations in planning could result in a deviation of the prior given production and loading plan as given by OS. Another example could be a strong deviation in a specific container demand in comparison to the priory determined annual allocation. One well-known forecast inaccuracy is the bull-whip effect. However, since demand is based upon actual deliveries, this does not account for the case study.

- **Unavailable material**
  The risk of unavailable material can be directly linked to the CA. This risk is linked to the supply of empty containers from Rotterdam and Antwerpen. The shipping line is responsible to provide the requested material at an assigned deep sea terminal or depot, in some cases, they are not able to do this. Unavailable material can be the result of many other risks, both within or outside the scope of this study. E.g. a delayed deep sea vessel or information distortions. It can also be the case that the shipping line has made the material available, but due to restrictions of the terminal, Alpherium is unable to pick the containers up by barge. Although not exactly similar, this risk is considered as unavailable (unattainable) material as well. The responsible party differs, but the effects are similar.

- **Optimistic barge planning (planning under high uncertainty)**
  The barge planner plans under high uncertainty, which can affect the barge planning and therefore the CA. Currently the barge planner does not work with an overall robust planning which could lower the quality of the barge planning and result in a less efficient use of the available transport capacity.

The next step is to link the identified risks to the categorization as defined in Chapter 2 The outcome can be found in Section 5-1-2.

Appendix E

Robustness of barge planning

To see how robust the current barge planning is, two barge plans were examined in detail. The considered process steps are part of the round trips. The availability of resources can be linked to the availability of quay slots and handling capacity (material and labour) at the deep sea terminals and depots. Route restrictions and terminal schedules can be seen as the constraints. Some of the terminals are open 24/7, others are closed at night resulting in a constraint to the barge planning. Bridges on the route from the deep sea terminals to Alpherium have opening hours as well, resulting in additional constraints. The time a barge needs for the trip to the deep sea terminal and back as well as between terminals or terminal and depot are process step times. The time a barge needs for being loaded or unloaded at a terminal or depot can also be seen as a process step.

The weeks that were examined were week 11 and week 12 of 2016. As a starting point the barge planning as it was on Friday was chosen. This way possible adjustments made by OS on Thursday or Friday to the detailed loading plan were included in the barge planning. The planning was examined per barge. In order to determine the robustness of the barge planning the trip times and handling times should be known. The shippers use loading reports to register when they arrive and depart each terminal or depot. These loading reports are combined, in order to calculate average trip times.

The loading reports per barge were combined, and based on conversations with the barge planner at Alpherium, terminals and depots visited by barges for Alpherium were determined. In principal there are now significant differences in trip times between barges. Based on the trip times found in the loading reports the average trip times were determined. Exceptionally long trip times were excluded from the calculation as they were likely to be the effect of a disruption or included the idle times of the shippers as well. Unfortunately, not all loading reports were filled in completely. This made it difficult to determine the waiting time (time between arrival and departure) per terminal, which was therefore not included in the calculation. According to the barge planner, in most cases the waiting time is close to zero. The average trip times are shown in the tables below.

In week 11 there were six barges as part of the transport capacity. On Friday the barge planner received feedback on quay slots for at least Friday through Tuesday. Because only one of six barges has appointments at deep sea terminals in the weekend, the weekend is not seen as part of the three-day prospect on quay slots. Every day, the barge planner receives confirmation of the coming three days. In some cases, he needs to reschedule due to long delays or limited terminal handling capacity. Tables E-1, E-2, E-3, E-4 and E-5 provide an overview of how we gained an insight into the time line of the barge planning. The first column shows the planned route, as known on Friday. The second column shows the planning on a daily level. The third column shows the planned arrival times. The column ETA stands for estimated arrival time. The column ETH stands for estimated handling time. The ETH is determined through multiplying the number of containers planned to be handled with the handling time per container. The handling times were determined based on conversations with the barge planner from Alpherium and Van Uden. On average a container handling (loading and unloading) at Alpherium takes 3.30 minutes, and 3:00 minutes per container at the deep sea terminals and depots. There is no difference in handling times between different type of containers. The ETD stands for Estimated time of Departure. The Estimated Time of Departure is determined by adding the ETH to the ETA. The ETA for the follow-up appointment is determined by adding up the trip time with the ETD.

As can be derived from Table E-1, the Friday version of the barge planning shows that on Wednesday the schedule is relatively tight. The appointment at terminal 524 in Antwerp is scheduled at 9:00, while the ETA is 9:39. The trip times are based on an average and the barge might be earlier in Antwerp than expected. However the barge could also be later than expected. The table shows that the barge does not have a lot of safety time between some of the different appointments and does not provide evidence of a planning impossible to follow. In some cases the safety time seems relative large, this is can be due to the fact that the shippers and crew need rest. And as stated earlier, only one of the barges is active during the whole weekend.

Table E-1: Domino week 11

		Planned	ETA	ETH	ETD
Alpherium	Friday	**07:00**	**07:00**	05:25:30	12:25
APM2	Friday	19:45	19:26	02:15:00	21:41
MBC	Saturday	06:00	23:41	02:15:00	08:15
Alpherium	Monday	**07:00**	**07:00**	04:50:30	11:50
APM 2	Monday	19:30	18:50	01:54:00	20:44
Kramer	Monday	23:00	21:29	02:33:00	00:02
Alpherium	Tuesday	07:00	06:02	05:11:30	11:14
730	Wednesday	06:00	23:04	03:12:00	09:12
524	Wednesday	09:00	09:39	01:36:00	11:15
Alpherium	Wednesday	22:00	22:55	05:36:00	04:31
APM 2	Thursday	13:00	11:31	01:54:00	14:54
Progeco	Friday	06:00	16:54	02:15:00	08:15
Alpherium	Friday	12:00	12:25	04:50:30	17:15
rst zuid	Friday		22:35		

Table E-2: Forever week 11

		Planned	ETA	ETH	ETD
Friday	Alpherium	16:00	16:00	03:02:00	19:02
Saturday	Alpherium	07:00	07:00	04:05:00	11:05
	APM2	20:45	18:05	02:36	20:41
	DDN	00:00	21:16	03:30	00:46
Monday	Alpherium	10:00	10:00	07:24:30	17:24
Tuesday	1700	06:00	06:24	01:06	07:30
Tuesday	1742	06:30	07:45	01:45	09:30
Tuesday	869	14:00	10:00	02:42	12:42
Wednesday	Alpherium	07:00	01:22	06:14:30	13:14
Wednesday	APM2	19:45	20:14	02:39	22:53
Wednesday	Kramer	23:00	23:48	02:51	02:39
Thursday	Alpherium	07:00	08:39		08:39

Table E-3: Domino week 12

		Planned	ETA	ETH	ETD
Alpherium	Friday	**07:00**	**07:00**	05:25:30	12:25
APM2	Friday	19:45	19:26	02:15:00	21:41
MBC	Saturday	06:00	23:41	02:15:00	08:15
Alpherium	Monday	**07:00**	**07:00**	04:50:30	11:50
APM 2	Monday	19:30	18:50	01:54:00	20:44
Kramer	Monday	23:00	21:29	02:33:00	00:02
Alpherium	Tuesday	07:00	06:02	05:11:30	11:14
730	Wednesday	06:00	23:04	03:12:00	09:12
524	Wednesday	09:00	09:39	01:36:00	11:15
Alpherium	Wednesday	22:00	22:55	05:36:00	04:31
APM 2	Thursday	13:00	11:31	01:54:00	14:54
Progeco	Friday	06:00	16:54	02:15:00	08:15
Alpherium	Friday	12:00	12:25	04:50:30	17:15
rst zuid	Friday		22:35		

Table E-4: En Avant week 12

		Planned	ETA	ETH	ETD
Friday	Alpherium	13:30	13:30	05:43:00	19:13
Saturday	DDE	03:00	01:33	02:42	05:42
Saturday	Kramer	08:00	06:02	02:24:00	10:24
Monday	Alpherium	12:00	12:00	06:14:30	18:14
Tuesday	RWG	00:00	01:04	01:15	02:19
	DDE	03:00	02:49	02:15	05:15
	DDN	05:00	05:20	01:45	07:05
Tuesday	Alpherium	14:00	13:25		

Table E-5: Tormenta week 12

		Planned	ETA	ETH	ETD
Friday	Alpherium	10:00	10:00	06:11:00	16:11
	APM	21:00	23:01	00:18:00	23:19
	APM2	22:30	23:44	01:48	01:32
	Kramer	03:00	02:22	03:15:00	06:15
Monday	Alpherium	01:00	01:00	06:18:00	07:18
	APM	12:00	14:08	01:54	16:02
	DDN	14:00	16:12	03:00	19:12
Tuesday	Alpherium	07:00	01:32		

It was found that five out of six barges in week 11 showed a Friday version of the barge planning with little safety time between some appointments. The two barges with the least robustness in the planning are shown above. Week 12 shows that of the Friday plans, four out of six barges showed plans with limited safety time between some appointments. Three of them are shown above. The limited safety time increases (the impact of potential disruptions and increases) the chance and impact of a barge arriving too late for a handling appointment. The impact of a delayed barge is discussed in Section 5-1-2.

Due to a lack of information the barge planner has to deal with uncertainties, forming a risk to the attainability of the barge planning. The planning technique of the barge planner increases this risk due to limited robustness.

Appendix F

TMA Calculation

F-1 In depth explanation

The TMA calculation is based on the relation between the barge planning and the planned transport capacity and the CA. Since the barge planning is based on the demand created by HNS, it is made in such a way the planned transport supplies the required empty containers. Thus when the transport capacity would decrease as a result of a disruption it forms a risk to the CA. As described, such a disruption could decrease the transport capacity in three different ways.

- Sailing with two layers of containers
- No sailing
- Longer trip times

Each of these effects can be the result of different disruptions and influence the transport capacity in different ways. Which can be shown through using the given formula.

No sailing

Logically, if due to a disruption sailing is not possible, it limits the maximum amount of sailing hours within the planned week. The result is shown below.

$$\begin{aligned} TMA &= \text{Theoretical average number of roundtrips} * \text{Barge capacity} \\ &= \frac{\text{Planned hours} - \textbf{non sailing hours}}{\%\text{Rdam} * 32 \text{ hours} + \%\text{Antw} * 48 \text{ hours}} * \text{Barge capacity} \end{aligned}$$

Sailing with two instead of three layers

This effect will directly influence the supply of empty containers in TEU. The result is shown below.

$$TMA = \frac{\text{Planned hours} - \text{non sailing hours}}{\%\text{Rdam} * 32 \text{ hours} + \%\text{Antw} * 48 \text{ hours}} * \text{Barge capacity} - \frac{\mathbf{1}}{\mathbf{3}}\textbf{Barge capacity}$$

Longer trip times

Longer trip times can be the result of a detour or a delay during sailing. For those times a delay does result in longer trip times, or when a broken bridge forces the barges to take a detour it can be incorporated in the formula in the following way.

$$\begin{aligned} TMA &= \text{Theoretical average number of roundtrips} * \text{Barge capacity} \\ &= \frac{\text{Planned hours} - \text{non sailing hours}}{\%\text{Rdam} * (32 \text{ hours} + \textbf{... hours}) + \%\text{Antw} * (48 \text{ hours} + \textbf{... hours})} * \text{Barge capacity} \end{aligned}$$

This formula can only be used when the added trip times account for the whole week. The disruptions that were found in historic data showed that the hours usually occurred for one or a few days. To limit complexity, such a detour will be handled equally as non-sailing hours. In a way the effect is similar, if a barge arrives four hours later because it lay still or whether it had to follow a detour does not affect the impact it has on the final outcome in capacity. Thus, in general longer trip times will be equally incorporated as non-sailing hours.

F-2 Scenarios

As stated in the main text, the effect a disruption to the CA can either be amplified or partly absorbed by a number of factors. These factors are:

- duration of the disruption
- Day of the week
- Follow-up appointment
- Planned barge capacity relative to needed barge capacity (overcapacity)

Duration of disruption

The duration of the disruption is incorporated into the disruption effect calculation. The impact of the duration depends on the type of disruption. In the case of non-sailing hours, the duration of the disruption is directly incorporated. The hours where sailing is not possible are subtracted from the theoretical maximum sailing hours.

If the disruption affects the sailing capacity of a barge, the duration is indirectly incorporated. The duration determines the times a barge can sail with two instead of three container layers. E.g. if strong winds last for two days, all barges sailing those two days can only transport two container layers. The missed capacity is directly subtracted from the TMA. The same accounts for an empty trip.

A duration of e.g. a detour as a result of a route obstruction incorporates the duration of a disruption in a similar way as non-sailing hours. It is calculated on a weekly basis and not a trip basis. The effect of a delay depends on the follow-up appointments and planning of other barges. This will be further discussed in the next paragraphs.

Day of the week

Chapter 4 described the planning process of the barge planning. The way the moment of a disruption can affect the barge planning has the do with this planning process. Figure F-1 shows a schematic view of the barge planning over the week. As stated earlier, every Wednesday the barge planner receives the demand by HNS through the detailed loading and production plan. This means that if a disruption would happen on a Tuesday, the event can be incorporated into the planning on Wednesday for the coming week and the impact could be minimized.

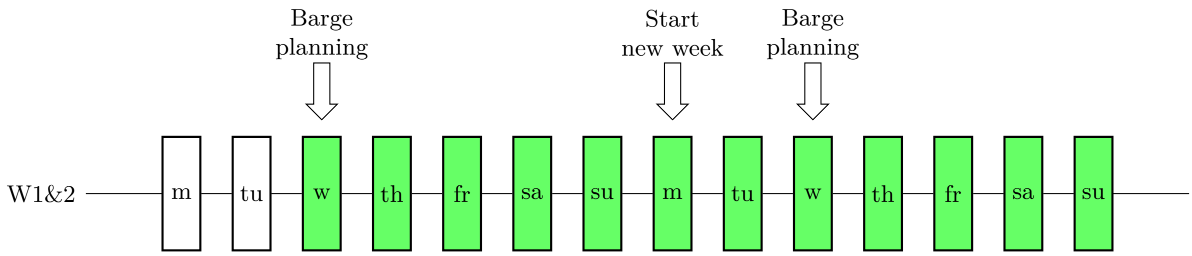

Figure F-1: Barge planning over the week

In order to understand how this affects the CA, it is important to state that part of the barge capacity is used to supply HNS' demand directly, and another part is used to increase the safety stock (which will be discussed in more detail in Section 8. Thus if a disruption affects journeys on a Monday or Tuesday, the barge planner can take this into account and use part of his barge capacity that was used to increase the safety stock to replenish the missed journeys of that Tuesday. Or in case of a severe disruption, the barge planner could choose to deploy extra transport capacity in the form of an extra barge or truck. This does not account if a disruption happens on a Thursday or Friday, as the planning is already set in motion. An added complication to a disturbance on a Friday is the close-down of the sailing route on Friday night. A disruption on a Wednesday is considered problematic as it increases the supply uncertainty the barge planner has to work with. A disruption on a Saturday and Sunday is expected to have a less significant effect on the transport capacity as most barges (apart from one) finish their shift Friday night or Saturday morning. On the other hand, if something happens, the barge planner is not able to directly adapt the barge planner as he has the weekend off.

If a disruption happens during the day or at night can slightly influence the impact. During the night, less barges are actives, as some terminals are closed during the night. On the other hand, the same accounts here as for weekend disruption. The barge planner cannot directly react to it and is therefore limited in his recovering actions to protect the CA.

Follow up appointment

If a disruption results in a delay, the effect of the delay on the transport capacity can depend on the follow up appointment. It was stated that in some cases the time between appointments was relatively short. If a delay is relatively small, the barge planner could ask the terminal operator to reschedule the appointment to a few hours later, which does not necessarily influence the barge planning, if time between appointments includes of sufficient safety times.

- E.g. when the barge arrives at an appointment scheduled for 15:00 o'clock at 17:00 o'clock and has to be back at Alpherium at 8:00 o'clock in the morning, it has no effect on the barge planning or the transport capacity since the time left for the trip back is more than enough.

If a delay occurs at a moment where the follow up appointment is planned shortly after the previous one, a delay could result in elimination of the follow up appointment. A possible result would be that either the barge has to wait and will get further delayed, or the barge has to make an empty trip.

- E.g. the barge has an appointment at a deep sea terminal at 14:00 o'clock to load empty containers, but due to a delay of 4 hours as the result of a disruption, can be there at 18:00 o'clock. However, the barge is expected back at Alpherium at 2:00 o'clock at night to load for the next round trip. The barge planner has to make a consideration about the importance of loading the empty containers, or being at Alpherium on time to pick up the loaded containers. If he chooses the latter, it would result in an empty return trip, decreasing the transport capacity directly.
- Another example is if the follow up appointment is scheduled in the port of Antwerp. E.g. if the barge was supposed to arrive at Alpherium in the morning, but due to a delay arrives in the afternoon, the follow up appointment is most likely not attainable any more as the shippers are expected to rest during the night if they are sailing to Antwerp, and most terminals in Antwerp are closed at night. Thus for such a trip, even a small delay could result in a missed trip because the barge planner cannot ask the terminal operator to reschedule the appointment a few hours later.

Planned barge capacity relative to needed barge capacity (overcapacity)

The impact of a disruption resulting in a decrease in barge capacity depends on the ratio planned capacity and needed capacity. If the planned capacity exceeds the needed barge capacity, the effect on the CA will be less than when the planned capacity is equal to the needed barge capacity. Now that we have established the different aspects and their impact on the CA and transport capacity, a number of scenarios can be depicted. The impact non-sailing hours and a delay can have on the barge capacity can be influenced through the safety time between appointments and whether or not all barges are active. The impact on the CA can be influenced through the amount of extra barge capacity and the day of the week a disruption takes place. This results in the following impact Table 5-5, depicted in Section XXimpact. A negative scenario indicates a higher impact on both the CA and the transport capacity. Table 5-5 can be used as an indicator to determine the overall scenario as predominantly negative, positive or average. A negative scenario increases the impact of the discussed disruptions.

Appendix G

Trigger file CA

The table below shows the trigger count over 2015. The first column shows the type of trigger, the second column shows the times the trigger was registered. One count can apply to one or more containers. The third column shows the percentage of that specific trigger as part of all triggers, and the fourth column shows the cumulative percentages.

Table G-1: Triggers registered 2015

Standaard reden	**Count of Niet beschikbaar aantal**	**%**	**Cumulative %**
rederij heeft geen containers	108	18%	18%
Nieuwe delivery Heineken	100	16%	34%
Depot heeft geen tijd	91	15%	49%
Planning Heineken meer dan 48uur naar voor	49	8%	57%
Vertraging lichter tijdens de reis	48	8%	65%
prio containers hebben voorrang (vol/leeg)	43	7%	72%
DHL freetime	36	6%	78%
Rederij geeft geen/niet op tijd een terugkoppeling	23	4%	82%
Capaciteit afhandeling Alpherium	22	4%	86%
(blank)	21	3%	89%
Vertraging depot/terminal	20	3%	92%
weer	15	2%	95%
Afkeuring containers Alpherium	9	1%	96%
Containers voor andere delivery uitgeleverd Alpherium	6	1%	97%
Delivery niet ingepland Alpherium	5	1%	98%
Terminal heeft niet voldoende containers bij uithalen	5	1%	99%
Uithaal referentie onbekend	5	1%	100%
Onjuiste data vermeld in SAP	1	0%	100%
Grand Total	**607**		

Appendix H

Tool development

This appendix is dedicated to the development, design and evaluation of the tool introduced in Chapter 7.

H-1 Disruption impact tool

Figure H-1 shows part of the tool that can be used to register all disruptions. As long as the combination of the different types of disruption results in an impact smaller than a total of two missed trips, the indicator remains the colour green. The first column indicates the week in which the disruptions are being registered. The second column shows the different barges, plus if necessary an extra barge, to which different disruptions can be linked to. The next five columns can be used to register a disruption. As stated in this research, different disruptions result in the same four impact categories to the transport capacity. These are a trip with two in stead of three layers, an empty trip, delays or non-sailing possible and added sailing hours. The barge planner can fill in how many times the impact has occurred per barge. The sixth column shows the number of missed trips per barge, which will all be added up in the seventh column, showing the total of missed trips. The two columns on the left can be used to fill in the date of a disruption and the cause. For example, due to strong winds, the barge Domino had to sail with two layers for one trip. An example of a filled in table is shown in Figure H-2.

Week	Lichter	Twee lagen reis (reize	Lege reis (reizen)	Vertraging/stil liggen (uren)	Omvaren (uren)	Gemist (reizen)	Totaal gemist (reizen	Datum	Oorzaak
1	Domino					0,0	0,0		
1	En Avant					0,0			
1	Forever					0,0			
1	Meta Maria					0,0			
1	Muguet					0,0			
1	Tormenta					0,0			
1	Extra					0,0			

Figure H-1: Disruption detection I

When the total of missed trips exceed the pre-determined two trips, the barge planner can fill in the disruption impact model. Figure H-3 shows the input that is linked to the barge

Week	Lichter	Twee lagen reis (reize	Lege reis (reizen)	Vertraging/stil liggen (uren)	Omvaren (uren)	Gemist (reizen)	Totaal gemist (reizen	Datum	Oorzaak
1	Domino	1				0,3	2,3		
1	En Avant		1			1,0			
1	Forever			4		0,1			
1	Meta Maria			8		0,3			
1	Muguet			6		0,2			
1	Tormenta	1				0,3			
1	Extra					0,0			

Figure H-2: Disruption detection II

planning of that specific week. The first column shows the week of occurrence, the second column shows the different possible barges, linked to their barge capacity in the third column. These columns are all pre-filled. The barge planner has to fill in the allocation per port of destination and the number of sailing days planned per barge. This will provide the outcome of the Theoretical Maximum Supply [TMA] per barge and in total. The other part the barge planner has to fill in is shown in Figure H-4. In the first column he can register the cause of disruption, the other four columns are used to fill in disruption impacts, similar to the detection registration table. This results in the outcome of the final TMA. Figures H-5 and H-6 show how a disruption impact in TEU is incorporated into the calculation. The first column shows TMA per barge that have incorporated the disruption impact. Figure H-5 shows the outcome when no disruption took place. Thus the TMA with disruption impact (second column) is no different from the earlier calculated TMA. Thus the difference shown in the third column is zero. The fourth column shows the difference in percentage, to provide an idea how big the impact was as a total of the pre-defined barge planning. Figure H-6 shows the outcome when a or multiple disruptions did took place.

Week	Lichter	Capacite	Allocatie Rdam	Allocatie Antw	Aantal vaardage	TMA	TMAtotaal
1	Domino	90	100,0%	0,0%	5	365	2376,4
1	En Avant	90	100,0%	0,0%	5	365	
1	Forever	104	100,0%	0,0%	7	617	
1	Meta Maria	81	100,0%	0,0%	5	319	
1	Muguet	90	100,0%	0,0%	5	346	
1	Tormenta	90	100,0%	0,0%	5	365	
1	Extra		0,0%	0,0%		0	

Figure H-3: Disruption impact I

	Verstoring					
Oorzaak	Reis met twee lagen (reis)	Lege reis (reis)	Minder vaaruren/Stil liggen (uren)	Omvaren Rdam (uren)	Omvaren Antw (uren)	Comment
	0	0	0	0	0	
	0		0	0	0	
	0		0	0	0	
	0	0	0	0	0	
	0	0	0	0	0	
	0	0	0	0	0	
	0	0	0	0	0	

Figure H-4: Disruption impact II

The outcome of the disruption impact appears in the next part of the tool, that is used as decision support. This is shown in Figure H-7. The outcome of the disruption impact model

TMA met verstoringseffect	TMAtotaal met verstoringseffect	Verschil (TEU)	Verschil (%)
365	2376,4	0,0	0%
365			
617			
319			
346			
365			
0			

Figure H-5: Disruption impact III

TMA met verstoringseffect	TMAtotaal met verstoringseffect	Verschil (TEU)	Verschil (%)
365	2096,1	280,3	12%
185			
573			
287			
346			
340			
0			

Figure H-6: Disruption impact IV

minus the usual overcapacity appears in the fourth column. The barge planner can fill in three different action plans. In the example we see a plan where recovery is done with two trucks, a plan where one barge is added to the transport capacity, and the final action combining the two. The tool provides a rough estimation of the costs per transport mode, and a total of the cost estimation. The final column shows the estimated duration of recovery, linked to the proposed actions. It can be seen that in this particular case, the impact was not high enough to add an extra barge, as a barge for a duration of 1.5 days is not realistic. It is assumed that in this case, the barge planner will choose to do no extra recovery actions to secure the restoring of the system to its pre-defined state. The usual overcapacity can replenish to safety stock to its desired level over time, if the risk of vulnerability is not considered too high. To secure CA t-0, truck transport might be added, an estimation of the price per day is given in this table.

Jaar	Week	Besproken (Datur	Verschil (TEU)	Actie	Actie	Actie	Trucks (aanta	Barge (aanta	Anders	Trucks (Eur	Barge (Eur	Anders nl. (Euro)	Totaal (Eur	Duur aanvullen gemiste capaciteit (Dag
2016	1		100,35				2			€ 9.620	€ -	€ -	€ 9.620	6,1
2016	1		100,35					1		€ -	€ 2.949		€ 2.949	1,5
2016	1		100,35				2	1		€ 1.890	€ 2.370		€ 4.260	1,2

Figure H-7: Decision support

H-2 Evaluation of tool

Figure H-8 shows the outcome of the What-if analysis with the different round trip times, as discussed in Section 7-2. The column TMAtotaal shows the calculation of the TMA, the column reality shows the actual supply of containers that week. The differences are depicted in the column left to reality. It can be seen that the differences ranges from 38.5 TEU to over 200 TEU. However, the total difference of the trip times as discussed in Chapter 7 was the smallest.

Week	Lichter	Allocatie Antwerpe	Vaaruren	TMAtotaal met bargecapaciteit	TMAtota	Opm	Difference	Reality	Realitytot
7	Domino	23,0%	120	322,2	1711		38,5	438	1673
7	En Avant	34,0%	120	305,3				269	
7	Forever	33,9%	168	517,1		Storm on Sunday		380	
7	Meta Maria	0,0%	24	63,9				81	
7	Muguet	0,0%	48	138,5		Na aankomst maandag uitge		150	
7	Tormenta	0,0%	120	364,5				355	
8	Domino	31,5%	120	308,8	1577	op woensdag	94,3	261	1483
8	En Avant	0,0%	120	364,5				323	
8	Forever	18,4%	96	319,0				274	
8	Meta Maria	0,0%	0	0,0				0	
8	Muguet	100,0%	120	220,4				178	
8	Tormenta	0,0%	120	364,5				447	
9	Domino	0,0%	120	364,5	1817		104,9	411	1922
9	En Avant	25,6%	120	318,0				411	
9	Forever	70,9%	168	439,2				372	
9	Meta Maria	42%	36	77,3				72	
9	Muguet	19%	120	312,2				328	
9	Tormenta	33,6%	120	305,8				328	
10	Domino	22%	120	324,6	1716,4		7,6	315	1724
10	En Avant	71%	120	259,3				269	
10	Forever	50%	168	480,0				452	
10	Meta Maria	0%	0	0,0				239	
10	Muguet	0%	120	346,4				269	
10	Tormenta	33%	120	306,2				180	
11	Domino	29,1%	120	312,5	1979,0		203,0	330	2182
11	En Avant	0,0%	120	364,5				446	
11	Forever	45,5%	168	489,8				448	
11	Meta Maria	0,0%	90	239,5				306	
11	Muguet	65,2%	120	252,3				270	
11	Tormenta	24,1%	120	320,4				382	

Figure H-8: Evaluation round trip times

Figure H-9 shows the evaluation of the calculation of the TMA compared to reality. The TMA's were all based upon the Wednesday versions of the barge planning of those weeks. The weeks with the biggest differences, week 13, 14, 26, 27, 28 and 29 were the weeks that had encountered disruptions.

Week 13 and 14 dealt with natural hazards and major delays at one of the deep sea terminals. During week 15, there was a route obstruction. Week 17 encountered another route obstruction as the result of an accident with a external barge and a bridge. Week 26 showed dealt with congestions at different terminals and a container shortage with one of the major shipping lines. Week 28 and 29 showed congestions and delays at one of the most important deep sea terminal and the depot for one of their major shipping lines; ECT. This is all depicted in Figure H-10.

	13		14		15		16		17		26		27	
	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality
Domino	269	296	221	144	306	270	296	300	286	239	285	227	221	272
En Avant	279	210	347	210	312	355	347	330	279	212	347	298	347	326
Forever	457	412	588	337	399	368	411	414	588	302	588	381	513	407
Meta Mari	304	181	233	100	200	222	304	296	237	96	229	129	0	0
Muguet	330	265	0	0	0	0	210	180	249	210	289	336	279	255
Parcifal	0	0	256	147	213	170	248	270	0	58	343	230	343	258
Tormenta	300	218	347	148	312	436	347	300	347	179	289	231	326	270
Vecht	0	0	0	0	257	153	0	0	0	0				
Eindtotaal	1940	1582	1992	1086	1999	1974	2164	2090	1986	1296	2370	1832	2030	1788
Verschil		358		906		25		74		690		539		242

	28		29		30		31		32		33		Totaal	
	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Som van Supplied TEU reality	Som van TMA met bargecapaciteitsbenutting (TEU)	Totaal Som van Supplied TEU reality
Domino	251	270	297	306	347	351	237	221	270	360	265	330	3552	3586
En Avant	304	236	347	236	347	359	285	234	300	327	251	270	4094	3603
Forever	493	300	555	416	456	407	456	409	588	510	508	376	6600	5038
Meta Mari	266	191	275	260	61	72	183	133	0	0	0	0	2291	1680
Muguet	286	220	290	248	278	266	66	81	330	290	330	390	2936	2741
Parcifal	273	202											1676	1335
Tormenta	300	326	251	178	347	330	291	264	290	261	296	300	4044	3441
Vecht													257	153
Eindtotaal	2174	1745	2015	1644	1835	1785	1517	1342	1778	1748	1650	1666	25451	21577
Verschil		429		372		51		175		30		-16		

Figure H-9: Evaluation calculation TMA

Opmerking		
	13	Vertragingen APM
	14	Vertragingen APM 30-3/Storm op 31-3
	15	Pasen/7-4 brug op Gouwe gesloten voor 8 uur
	16	
	17	Stremming Gouwe vanwege aanvaring met brug, 2 dagen omvaren via adam
	26	Achterstanden ECT vanwege personeelstekort/problemen planning Uniport/onvoldoende materiaal hanjin
	27	Achterstanden ECT vanwege personeelstekort
	28	
	29	vertraging op ECTcity
	30	storm in het weekend
	31	
	32	
	33	

Figure H-10: Overview issues

Appendix I

Safety stock adaptations

This Appendix has been removed for confidentiality reasons.

Appendix J

Contingency plan adaptations

Figure J-1 provides a schematic view of the adapted contingency plan. The grey blocks represent information required to "determine measures and define decisions to prevent unplanned downtime of production lines and depletion of market stocks". The grey blocks represent information that should be exchange during the meeting, as part of the contingency situation. The grey blocks with the dotted lines, represent information, that is not known during a normal operation. These should be attained beforehand of the meeting. The grey blocks together form the input for the key information sources, which are depicted by yellow blocks.

The CA represents which containers are and which are not available, and thus the aim of the recovery actions. The risk of shutting down production follows from the degree of an insufficient CA and the amount of storage capacity available at the warehouse. Product priorities reflect what containers could be delayed, and which have a high priority of being transported to the overseas market on time. The output of the disruption impact model provides a quick overview on how much transport capacity was lost due to a disruption, and can be quickly linked to required recovery actions in the form of added transport capacity.

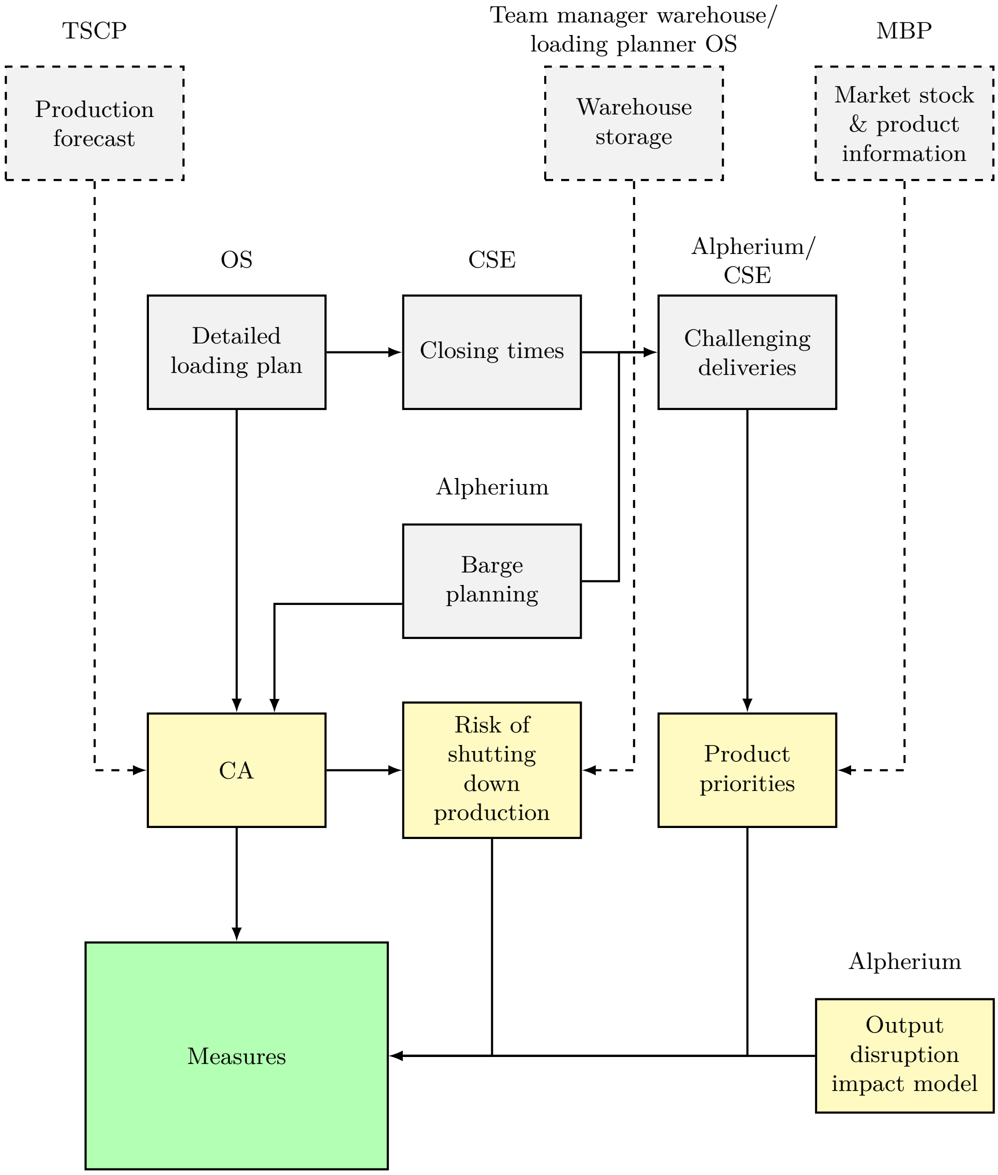

Figure J-1: Schematic view of adapted version contingency plan