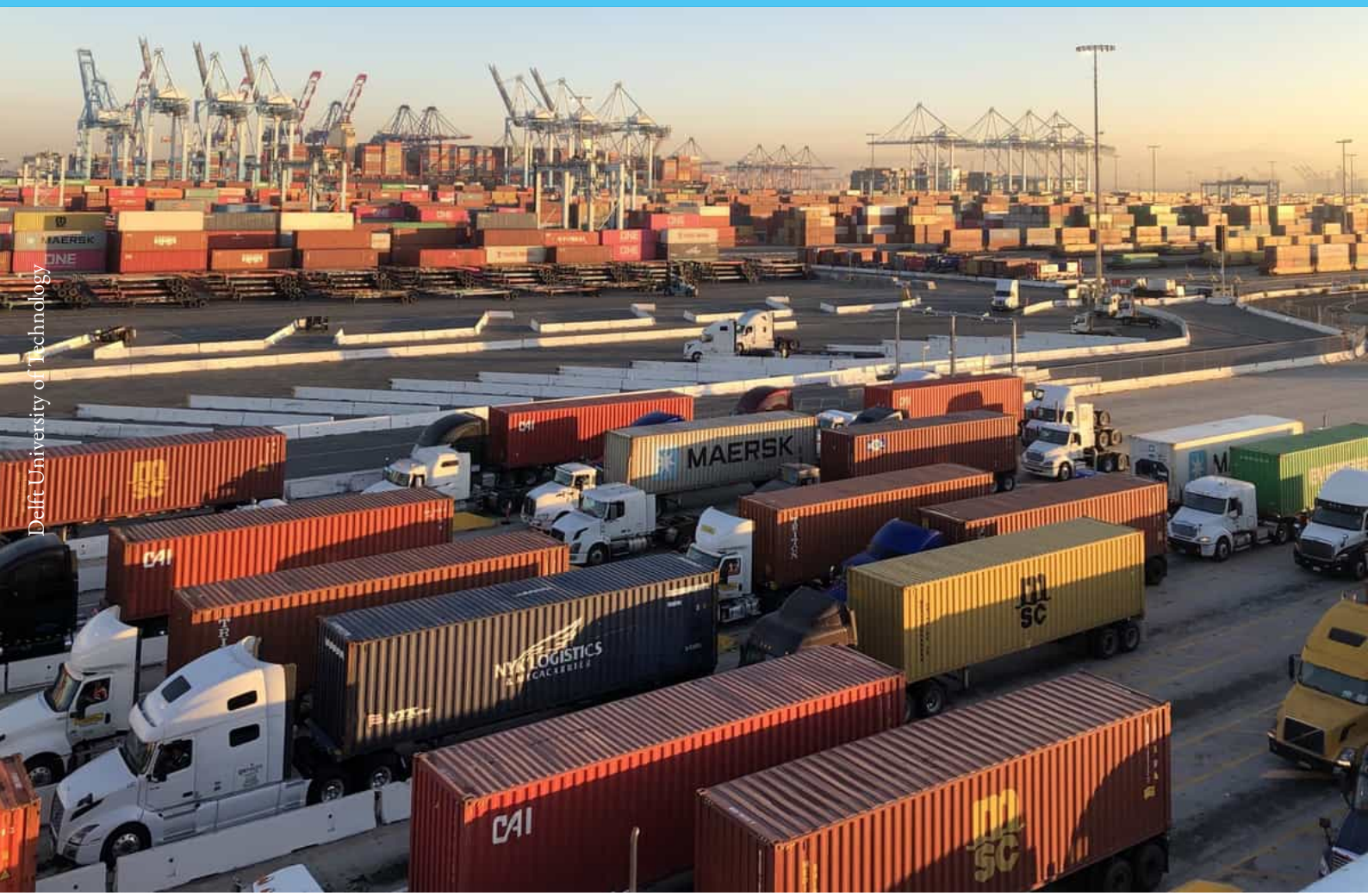
Night-time container transport between port and hinterland using a hub with extended opening hours

A case study for the port of Rotterdam

Ella de Kerpel

MSc Thesis Transport, Infrastructure and Logistics



Delft University of Technology

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Port of Rotterdam

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Preface

This is the report of the thesis project to obtain my Master of Science degree in Transport, Infrastructure and Logistics at the Technical University of Delft. The project was conducted at the Port of Rotterdam, where I started my graduate internship in September 2021. This thesis tackles the growing problem of truck congestion at container terminals in seaports by investigating the use of a hub with extended opening hours to better facilitate night-time container transport. The subject of this research was chosen to combine the wish of the Port of Rotterdam to investigate new solutions to reduce waiting times at their terminals, with the literature gap found in an extensive literature review on existing research on this topic. I enjoyed working on this thesis, together with people from the Port of Rotterdam and the TU Delft, very much. It helped me to get a better view on logistical problems and how the involvement of various actors affects the possibilities to solve these problems. I also learned a lot on how to combine various methods that I learned during my study in Delft, using programs of which some were completely new to me, to answer one main research question.

Many thanks to Stefano Fazi, Ali Nadi and Sijbrand Pot for their frequent supervision and to Lóri Tavasszy and Arjan van Binsbergen for their help and feedback during important meetings. I would also like to thank Bart Wiegmans for his help during the first half of my thesis. Furthermore, I want to thank everybody at the Port of Rotterdam who helped me gain information about operations in the port and all people who participated in the interviews for my research. Lastly, I would like to thank all my family and friends for their support during my whole study at the TU Delft. I hope you will enjoy reading this report and that it will be of use in future decision-making concerning the truck congestion problem at the Port of Rotterdam!

Ella de Kerpel
Rotterdam, March 2022

Summary

Over the last years, international trade volumes have been increasing rapidly. Because of this, efficient container transport between seaports and their hinterlands is becoming a more significant challenge. In European seaports, the largest share of containers transported from and to the hinterland belongs to the truck mode. Even though most terminals at the ports are open 24 hours a day, most trucks visit terminals only during peak hours. During these peak hours, truck congestion at terminals' gates is growing and has various consequences. The most important consequences are the increasing waiting times, high costs for trucking companies, frustrated truck drivers, truck drivers exceeding their legal working hours, containers arriving too late at the hinterland, a lower attractiveness of the port, high emissions of idling trucks and lastly, congestion on the infrastructure surrounding the port. The Port of Rotterdam recognises these problems and wants to analyse this problem further. Thus, this research focuses on mitigating truck congestion at container terminals in the port of Rotterdam.

A literature review is done on reducing truck congestion at container terminals. Possible solutions for this problem can be divided into three categories; (1) increase the supply, (2) decrease the demand and (3) better match supply and demand. Increasing the supply of terminal operations can be done by expanding the physical capacity or decreasing the turnaround time of trucks visiting terminals. However, increasing terminals' capacities has limitations. Furthermore, this could lead to even more congestion in other areas like the terminal yard or surrounding highways. Reducing the truck demand at terminals could be done by increasing the modal split of other modes like trains and barges. Much research is devoted to intermodal transport. However, truck transport remains the mode with the highest share of hinterland container transport, mainly because of its speed and flexibility. Thus, solutions for more efficient container transport by truck are needed. Better matching the supply and demand could be done by spreading the truck arrivals more evenly over the whole day. Stimulating off-peak container transport between the port and hinterland can be done by (1) restrictions, (2) encouragement and (3) better facilitation. First of all, trucks could be forced to move to off-peak hours using a truck appointment system, limiting the number of trucks per period. Secondly, trucks could be encouraged to arrive at night using monetary incentives. Both these policies have led to some successful results. However, the main challenge that remains a problem is that receivers in the hinterland are often only open during working hours. Because of this, even if trucking companies want to perform night-time container transport, they can not deliver the containers in the hinterland. The third option to stimulate off-peak transport tackles this problem, as it seeks to improve the facilitation of off-peak transport. A possibility of doing this is adding a hub with extended opening hours to the container transport system. As shown in figure 1 container would be transported between the port and the hub during off-peak hours, while the container transport to and from the hinterland could still be performed during working hours.

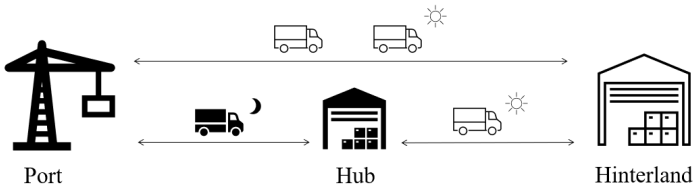

Figure 1: Hub with extended opening hours

Several challenges arise with this solution. First of all, many different actors are involved in container transport between ports and the hinterland, like trucking companies, receivers, freight forwarders and terminals. No actor has yet invested in a public hub with extended opening hours, as no research is done on what hub characteristics will lead to actors using the hub. Thus, this research aims to evaluate the actors and their (inter)actions in the container transport system and analyse the effects of designing night-time container transport using a hub with extended opening hours to mitigate truck congestion at terminals' gates in several scenarios.

The main research question of this thesis is the following:

How can truck congestion at terminals' gates be mitigated designing night-time container transport between port and hinterland using a hub with extended opening hours?

A well-suited method for evaluating actors, their behaviours, and their interactions is agent-based modelling. Agent-based modelling is used to simulate autonomous actors with their (inter)actions to observe effects on a whole network and is used often for simulating freight models. The steps for developing an agent-based model are used to set up the sub-questions that have to be answered to answer the main research question. The sub-questions in the research are the following:

1. What actors can make decisions about night-time container transport?
2. What influences each actor's decision that can lead to night-time container transport?
3. How can these actors' decisions and their interactions be modelled?
4. What are the possible waiting time gains at terminals' gates from facilitating night-time container transport between port and hinterland using a hub with extended opening hours in several scenarios?

The first two sub-questions are answered by literature research and semi-structured interviews with actors. Actors that are interviewed are trucking companies, receivers, freight forwarders, a terminal, the Port of Rotterdam and the Ministry of Infrastructure and Water Management. Trucking companies could profit from a hub with extended opening hours because of lower waiting times at terminals and a possibility of transporting more containers as the total time of transporting one container reduces when using a hub. If trucking companies used the hub, the receivers of these containers could benefit from more reliable transport, as long waiting times at terminals are avoided. Terminals, the Port of Rotterdam and the Ministry of Infrastructure and Water Management would also profit from less truck congestion, fewer emissions from idling trucks and higher attractiveness of the port and its terminals. After analysing the interviews, it was found that trucking companies make the final decision of performing day or night transport and possibly using a hub with extended opening hours. However, other actors influence their decision, for example, if receivers in the hinterland would pay trucking companies extra to perform night-time transport or use a hub. For answering sub-question 3, an agent-based interaction model is designed, including all important actors and their interactions. Using this, the container transport system is simulated in the program Anylogic, using agent-based modelling and discrete event simulation. By adding a hub with extended opening hours to the system, the effects on the waiting times at terminals' gates are analysed in several scenarios. The modelling framework is shown in figure 2. The bold text is data that is input for the model, and the dotted lines signify that the actions of this arrow are only being executed once.

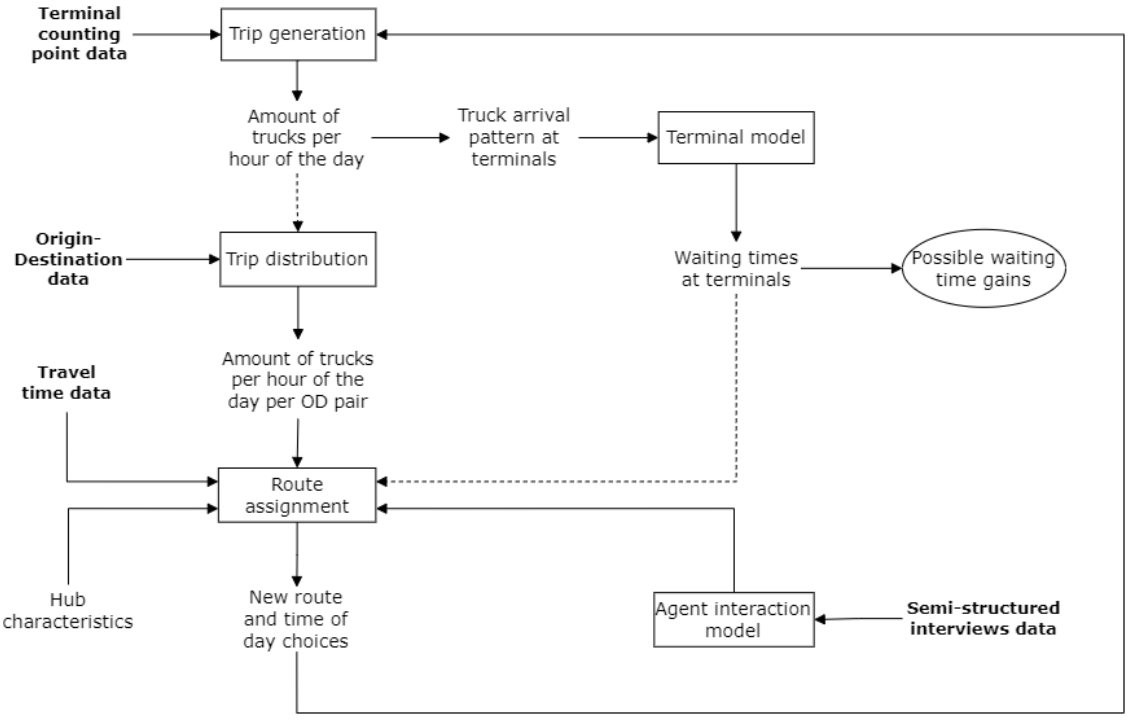

Figure 2: Modelling Framework

As can be seen in the modelling framework, the four-step model is used for transport forecasting (excluding the mode split, as this research only focuses on truck transport). The input for the trip generation is the truck arrival data from counting points in front of four of the container terminals in the port of Rotterdam. These counting points measure the number of trucks arriving and leaving every terminal per hour of the day. The number of trucks leaving every terminal is used to calibrate the terminal model, a queueing model with a certain number of gates, a minimum service time and lambda for the exponential service time distribution. After calibration, verification and validation, the model can be used to calculate the current waiting times at terminals. After finding the results of the base case, the following scenarios of introducing a hub with extended opening hours are set up:

Table 1: Scenarios of adding a hub with extended opening hours to the model

Scenario	Type of hub	Turnaround time (minutes)	Total costs per truck (euros)	Capacity (# of trucks)	Location
1	Chassis-exchange	10	€15 - €20	100	Maasvlakte
2	Chassis-exchange	10	€15 - €20	100	Botlek
3	Chassis-exchange	10	€15 - €20	200	Maasvlakte
4	Chassis-exchange	10	€15 - €20	200	Botlek
5	Container hub	20	€30 - €50	300	Maasvlakte
6	Container hub	20	€30 - €50	300	Botlek

The trip distribution is based on origin-destination data from TomTom. This information, together with the hub characteristics, the current waiting times, the travel times retrieved with the Distance Matrix API from Google Maps, costs for driving and waiting and the agent interaction model, leads to the route assignment. The route assignment is a discrete choice model of trucking companies deciding to drive directly between the terminals and the hinterland or use a hub with extended opening hours. Parameters of this multinomial logit model are the costs of transporting one container and the time it takes to transport this container. The latter is essential as the faster a container can be transported, the more containers a trucking company can transport per day and the more profit it can make. Using the probability that trucking companies would choose the hub route alternative, the number of trucks that want to use the hub is modelled. Sensitivity analyses on the costs for trucking companies for using a hub with extended opening hours show that the maximum estimated costs of chassis-exchange, which is €20 per truck, always leads to a higher demand for using the hub than its capacity. When varying the hub costs of the scenarios where a container hub is added to the system, the entire hub capacity is only used if other actors partly pay for using this hub. If only 100 or 200 trucks used the container hub, the waiting time gains would be comparable to the chassis-exchange scenarios with a capacity of 100 and 200. Thus, depending on the exact hub costs, scenarios 5 and 6 are run assuming other actors pay €7.58 to €22.73 and €15.15 to €30.30 per container, respectively, so the container hub capacity is fully used. The new time of day choices are modelled in every scenario, and the possible waiting time gains are analysed. Table 2 shows the waiting time gain of every scenario. Furthermore, the operational time gain of all trucks that switch to use the hub is given. This includes the waiting time in front of terminals, the driving time between the terminals and hinterland and the time of visiting the hub. The * next to scenarios 5 and 6 signifies that the amount that other actors pay trucking companies for using a hub is different than in the other scenarios, which should be considered when comparing the scenarios. The total current waiting time costs are €41.769 per day.

Table 2: Results per scenario

Scenario	Hub preferences (#)	Hub users (#)	Total waiting time gain per day (hours)	Total monetary gain per day (euros)	Operational time gain per day (hours)
1	580 - 1.276	100	239	€9.158	15
2	225 - 625	100	212	€8.130	10
3	580 - 1.276	200	421	€16.133	33
4	225 - 625	200	373	€14.293	20
5*	0 - 323	300	338	€12.952	54
6*	0 - 320	300	425	€16.286	-29

In all scenarios, introducing a hub with extended opening hours can lead to waiting time gains of around 3 to 6 million euros per year. However, the scenarios with a container hub need other actors to partly pay per container for trucking companies using the hub. Even though some receivers may want to pay extra to reduce the chance that some of their

containers arrive too late, it is hard to ensure this payment for every container. Furthermore, the total operational time of trucks using the hub is greater in scenario 6 than in the current situation. A reason for this could be that not many trucks want to use this hub (only some trucks with very high waiting times), and the hub in the Botlek area is probably not on the route between the origin and destination of most of these trucks. Moreover, as the waiting time gain is not higher in scenario 5 than in scenario 3, where a chassis-exchange without payment of other actors is introduced, implementing a container hub does not seem like the best solution for mitigating the waiting times at container terminals. Scenarios 1 to 4 do not include extra payment of other actors. It can be seen that the number of trucks that want to use a hub located on the Maasvlakte is twice as high as the number of trucks that want to use a hub located in the Botlek area. Furthermore, the operational time gain is also higher when the hub is located on the Maasvlakte. This is because driving past this hub is almost no detour for all trucks, as all container terminals are located on the Maasvlakte. As expected, the waiting time gains of the chassis-exchanges with a capacity of 200 are almost double that of the chassis-exchanges with a capacity of 100. Depending on the capital of actors investing in the hub with extended opening hours, a chassis-exchange with 200 parking places located on the Maasvlakte (scenario 3) leads to the best results and can be seen as the most promising scenario. The waiting time gains of this scenario can be seen in figure 3.

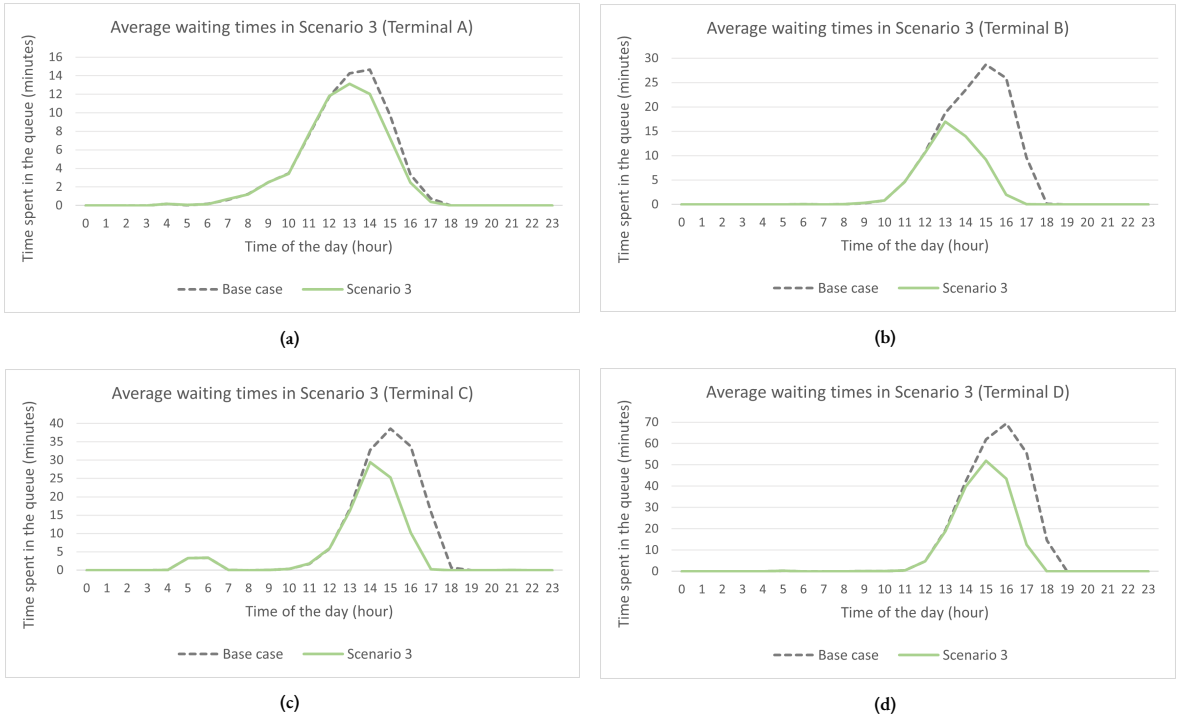

Figure 3: Averaged simulated waiting times per time of the day for every terminal in scenario 3

The waiting time gains can be seen as the system gain of adding a hub with extended opening hours, as all trucks visiting the terminals profit from this, instead of only the trucks using the hub. However, trucking companies switching to night-time container transport experience more gain than only the reduced waiting times. The operational time gains could lead to them being able to transport more containers per day. If the trucking company has enough demand to ensure night-time transport for every day of the week, shifting one or more trucks to the night could lead to significant opportunities. The terminal visits between 13:00 and 18:00, which are the busiest hours of the day, should be transferred to the night. Suppose, for example, a truck that drives at night transports one import container and one export container between the terminals and the hub for 6 trucks that perform daytime transport. In that case, these trucks could have up to 3 extra hours to perform other activities during the busiest hours of the day. These hours could, for example, be used to transport other containers between the terminals and the hinterland.

As many actors benefit from reduced waiting times at terminals' gates, various actors could choose to invest in a hub with extended opening hours. The CAPEX of building a chassis-exchange are estimated to be lower than the CAPEX of building a container hub. The reason for this is that no expensive reach stackers are needed. However, new chassis need to be bought to use the total capacity of the chassis-exchanges. The estimated CAPEX are approximately €1.360.000 for a chassis-exchange with 100 parking places, €2.720.000 for a chassis-exchange with 200 parking places and €3.000.000 for

a container hub with the capacity of 300 trucks. Actors should have enough capital to pay for these capital expenditures. If this is not the case, various actors could combine their capital to invest in a hub with extended opening hours. For example, multiple trucking companies could invest in a hub together. If trucking companies would profit from owning this hub, they could send their trucks to use it even though it is not more profitable for every truck, as was the case for a container hub. As shown in figure 4, if no other actors have to pay for trucks using the hub, it was found that trucking companies could profit most from investing in a container hub located on the Maasvlakte, depending on the exact hub costs and revenues. However, the profit of investing in this container hub could also be negative. Further research on the exact hub costs and extra revenues of transporting more containers should be done to analyse the estimated profit better. A solution with less uncertainty is investing in a chassis-exchange on the Maasvlakte. The estimated profits of trucking companies investing in this hub are always positive and higher than a chassis-exchange in the Botlek area. If the trucking companies investing in this hub would have enough capital, a chassis-exchange with 200 parking places is recommended over a chassis-exchange with 100 parking places, as the yearly profit is more twice as high. If trucking companies would invest in a chassis-exchange on the Maasvlakte with a capacity of 200 trucks, the payback period of their investment would be approximately 1.7 to 3.5 years.

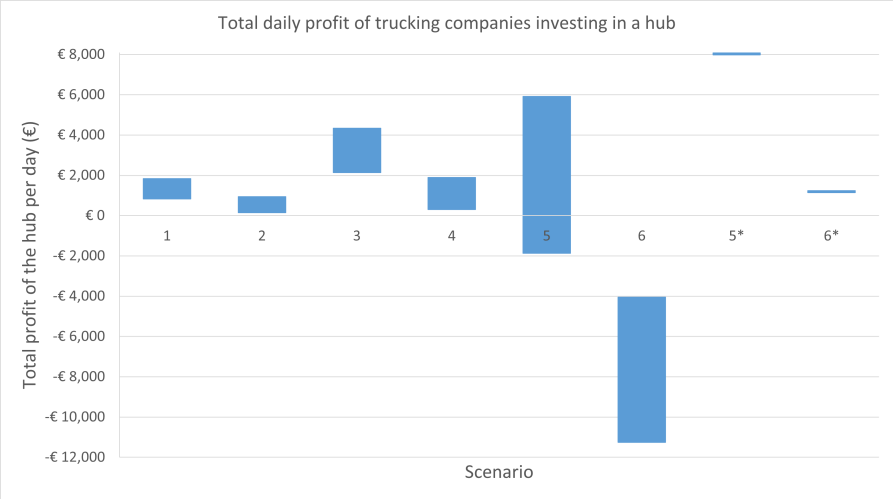

Figure 4: Total daily profit of trucking companies investing in a hub for every scenario

If other actors like receivers, terminals, the Port of Rotterdam or the Ministry of Infrastructure and Water Management invested in a chassis-exchange, the profit would depend on the costs of the hub and the price the owners of the hub ask for trucking companies using their hub. The latter depends on if the goal of the hub owner is to participate in facilitating night-time transport to reduce waiting times at the terminals or make as much profit as possible. The maximum profits to be made by other actors investing in a chassis-exchange are estimated to be €500 per day in scenarios 1 and 2 and €1.000 per day in scenarios 3 and 4. Investing in a container hub is not recommended for other actors than trucking companies. As not enough trucking companies would want to use this hub, other actors need to pay for trucks using this hub, which is not easy to assure for every container.

One of the main reasons why currently not many actors are thinking about investing in a hub with extended opening hours is that it was unknown when actors would use such a hub and whether the investment would be profitable for them. This research could be beneficial for the discussion and actual implementation of a hub with extended opening hours. This research aims to be another incentive for actors to move towards the implementation of a hub with extended opening hours. This research is mainly done using Anylogic as a simulation model because of its face validity. The model can be easily shown and will be explained to the Port of Rotterdam and other actors in the system. Lastly, it is recommended to research the exact place of introducing a hub and the precise CAPEX, costs and revenues of investing in a specific hub to put the findings of this research into practice. This research should consider all essential factors like the distances to the surrounding neighbourhoods. Furthermore, the complete counting point data and a more thorough route choice model could be considered to drop some assumptions made in this research. Moreover, future research is recommended on horizontal collaboration between small trucking companies and policies like charging a fee to trucks visiting the terminals during peak hours. Combining this with a hub with extended opening hours could lead to more waiting time gains.

Contents

Nomenclature

Abbreviations

Abbreviation	Definition
PoR	Port of Rotterdam
I&W	Infrastructure & Water Management
TAS	Truck Appointment System
ABM	Agent-based modelling
DES	Discrete event simulation
DCM	Discrete choice modelling
MNL	Multinomial logit model
ASC	Alternative specific constant
OD	Origin-Destination
FIFO	First in, First out
MSE	Mean square error
MAPE	Mean absolute percentage error
OPEX	Operational expenditures
CAPEX	Capital expenditures

Glossary

As a hub with extended opening hours, a chassis-exchange and a container hub are important terms in this research, that can be interpreted differently by everyone, the definitions of these terms, as used in this report, are stated below.

Definition	Description
Hub with extended opening hours	A location to store containers with opening hours greater than normal working hours. It is designed so that trucks can transport containers between the terminals and this hub during off-peak hours to avoid terminal congestion. Other trucks then transport these containers between this hub and the hinterland during working hours, as that is when receivers in the hinterland are open. This hub could be designed like a chassis-exchange or a container hub.
Chassis-exchange	A hub with extended opening hours where containers are stored with the chassis it is placed on. A truck visiting a chassis-exchange could leave its chassis with a container and pick up another one. Thus, chassis are used by multiple truck drivers. Extra chassis have to be bought to be stored at the chassis-exchange. However, a new chassis does not have to be acquired for every container, as the existing chassis of trucks that will use the hub can be used to store containers at the chassis-exchange.
Container hub	A hub with extended opening hours where containers are stored by stacking them on top of each other. A reach stacker is used to remove a container from the chassis of a truck on the container pile and to place another container on the chassis of the truck.

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1 Introduction

1.1. Problem definition

Over the last decades, global trade has been growing rapidly. The volumes of international container transport are increasing every year. This has led to higher profits for multiple actors like ports, terminals and deep-sea carriers. However, not all the elements of global supply chains can handle this increase in container transport, which leads to new challenges. One of these challenges can be found at container terminals, which are essential nodes in these global supply chains (Azab and Eltawil, 2016). Large container terminals are the connection between sea and hinterland transport. Because of the increasing global container volumes, the number of containers that have to be transported between ports and the hinterland is also expanding (Bouchery et al., 2014). According to Behdani et al. (2020), the weakest transportation link for many seaports is the hinterland access, because of congested roads and insufficient or non-existing railway connections that lead to delays and extra costs. Furthermore, as the hinterland that ports can supply expand, they start overlapping and several seaports can supply the same hinterland. Ports are becoming part of intermodal networks, which ensures that competition moves from being between ports to being between the total transport chains, including hinterland transport (de Langen and Chouly, 2004). In European seaports, the largest share of containers that are transported from and to the hinterland belongs to the truck mode. In 2017, the share of trucks as a modality was 58% in Rotterdam, compared to 55% in Antwerp, 52% in Hamburg and 51% in Bremerhaven (BinnenvaartCijfers, 2017).

The increasing truck transport between ports and the hinterland is leading to problems at the terminals. Ports acknowledge that during peak hours the demands at the terminal gates are exceeding the capacity of the terminals, while in off-peak periods, that are night times and weekend days, almost no trucks are arriving at the port terminals (Lubulwa et al., 2011; Bentolila et al., 2016). Because of the increase in international container transport, congestion in the peak hours and thus high waiting times for trucks arriving during the day are increasing rapidly over the years, sometimes up until several hours (Zhang et al., 2019). Due to long waiting times, truck drivers are standing still for a large part of their working day and thus making less profit. At this point, they are very frustrated with these waiting times and they demand solutions from the container terminals (Rijnmond, 2020). Not only does the congestion in peak hours create high waiting times, but the idling trucks are generating high emissions including the most harmful air pollutants (Li et al., 2018). On top of that, peak hours at container transport do not only cause congestion at the terminals in the ports but also on the surrounding infrastructure. According to calculations of Panteia, the total economic loss because of truck congestion on the dutch highways, partly due to the peak hours at the port of Rotterdam, has increased up to 1.2 to 1.5 billion euros in 2019 (TLN and EvoFenedex, 2020).

1.2. Knowledge gap

A lot of research has been done on reducing truck congestion at container terminals. A literature review on previous papers in this area can be found in chapter 2. Possible solutions for this problem can be divided into three categories; (1) increase the supply, (2) decrease the demand and (3) better match supply and demand. The first possible solution to reduce truck congestion at container terminals is to increase the capacity of the terminal by expanding the physical capacity or decreasing the turnaround time of trucks visiting terminals. However, this solution has limitations as the terminals can not always expand anymore. Furthermore, increasing the number of trucks terminals can handle per hour could lead to (even) more congestion in other areas, like the terminal yard and highways surrounding the port (Guan and Liu, 2009; Visser et al., 2007). Also, terminals are probably not very interested in increasing their capacity as they state waiting times are not their problem and trucks should change their arrival patterns (Giuliano and O'Brien, 2007); Giuliano et al., 2008). The second way of reducing truck congestion at container terminals is to decrease the demand for trucks arriving at the terminal. This could be accomplished by increasing the modal split of other modes like trains and barges. A lot of research is devoted to this intermodal transport and intermodal hubs. Intermodal hubs are mainly

being implemented because transport by train and barges is at this moment more sustainable than truck transport (Merk and Notteboom, 2015). Even though railway transport and inland shipping are being encouraged for years, truck transport remains the transport mode with the highest share of hinterland container transport. The main reasons shippers are choosing to let their containers be transported by truck are that trains and barges are large-capacity services that perform low frequent transport with low speeds and are less reliable, which is not very competitive to truck transport on short distances (Visser et al., 2007; Meers et al., 2016; Meers et al., 2018). Furthermore, building new waterways and railway infrastructures is costly and takes a lot of time (Motono et al., 2016), while short-term solutions are needed in this present truck congestion problem. In the future, electric trucks could ensure that road transport leads to fewer emissions than diesel trucks do at this moment. The last reason for not further researching intermodal hubs is that already a lot of existing literature is focusing on this, and solutions for truck transport have not often been the topic of research. The third way to reduce truck congestion at container terminals is to better match supply and demand by spreading the truck arrivals more evenly over the whole day. At the port of Rotterdam, only 6.9% of the trucks are arriving at night, while the terminals are open 24 hours per day and 7 days per week (Smits and Zomer, 2021). Various papers and experiments in multiple sectors have investigated moving transport to off-peak hours and have concluded that there are a lot of advantages of off-peak distribution (e.g., Holguín-Veras et al., 2005; Holguín-Veras et al., 2008; Gnap et al., 2017). The next paragraph focuses on policies for spreading truck arrivals.

There are several policies to stimulate off-peak container transport between seaports and the hinterland, that can also be divided into three categories; (1) restricting, (2) encouraging and (3) better facilitating. First of all, trucking companies could be forced to move to off-peak hours by the use of a truck appointment system. This system limits the number of trucks that is allowed to arrive at the terminals in certain time periods and has been popular in previous literature (e.g., Guan and Liu, 2009; Azab and Eltawil, 2016; Neagoe et al., 2021). However, there have been unsuccessful implementations in the past and there are several known shortcomings of these systems. Examples of this are the fact that truckers can not exactly know when to arrive at a terminal 24 hours in advance, the insufficient possible appointments given by the terminals, the lack of flexibility, the inability for truck drivers to fulfill their second/afternoon appointments and the problems that arise because of the restrictions of the supply chain like the opening hours of distribution centers (Giuliano and O'Brien, 2007; Giuliano et al., 2008; Merk and Notteboom, 2015; Motono et al., 2016; Huynh et al., 2016; Rijnmond, 2020). The second policy to stimulate off-peak transport, which is sometimes combined with a truck appointment system, is the promotion of off-peak transport with the use of monetary incentives. However, research shows that this policy is often implemented unsuccessfully. Several reasons for this are found, like noise complaints from inhabitants of the surrounded area and extra costs of carriers for driving at night. However, the main reason that was by far stated the most in existing literature, is that even though carriers would accept transporting during off-peak hours, receivers of containers in the hinterland do not accept off-peak deliveries, as they comply with normal working hours (Holguín-Veras et al., 2007; Holguín-Veras et al., 2008; Verlinde et al., 2010; Bentolila et al., 2016). The third possible solution to spread truck arrivals at container terminals is to better facilitate off-peak transport. A possible measure to shift to more night-time transport without trucks arriving at receivers during off-peak hours is the introduction of a hub with extended opening hours. Trucks will perform the transport of containers between the sea terminals and this hub during the night, which would spread the peaks at the container terminals. Meanwhile, trucks can perform the transport between the hub and the hinterland in the daytime as receivers are demanding. Figure 1.1 illustrates this container transport by trucks with the option to use a hub with extended opening hours. This concept has been researched a lot in urban distribution systems, where central receiving centres are used for trucks arriving at night-time and freight being transported between the centre and receivers during normal working hours (Holguín-Veras et al., 2008).

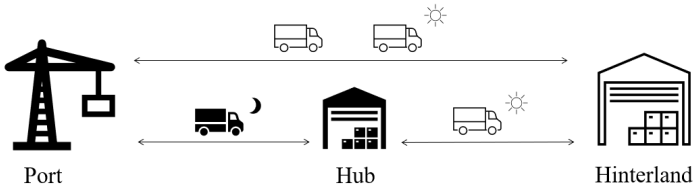


Figure 1.1: Hub with extended opening hours

When introducing a hub with extended opening hours to facilitate night-time container transport, several challenges need to be taken into account, for example, the costs of using the hub and the costs of transporting containers during the night. Furthermore, research states that freight transport is a complex problem as many different actors are involved in container transport between ports and the hinterland, for example freight forwarders, shippers, transport operators,

port authorities and terminal operators (de Langen and Chouly, 2004; van den Berg and de Langen, 2015; Behdani et al., 2020). Moreover, diverse interactions like on the one hand long-term contracts between carriers and suppliers and on the other hand prices and services settled through the spot market create a complex network (Roorda et al., 2010). Whether a new logistic solution, like the implementation of a hub with extended opening hours, will operate successfully, thus actually reducing waiting times at terminals' gates, depends on how it is implemented and the behaviour of all the actors involved. According to Veenstra et al. (2012), one of the main challenges of the implementation of such a hub will be the selection of the characteristics of the hub to make sure that actors in the hinterland network will use it. In figure 1.2, a graph is shown with actors involved in the container transport system at the port of Rotterdam and the main interaction flows between them, wherein in some cases one company can act like several of these actors. When introducing a hub with extended opening hours in this system, how these actors are interacting and which actor should for example pay for using the hub, are important factors that influence the effects on the truck congestion at terminals' gates.

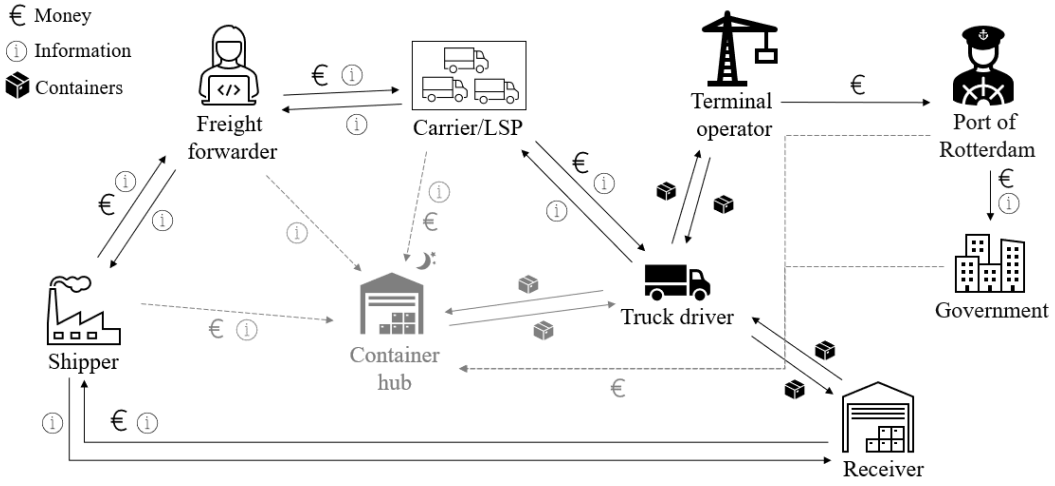


Figure 1.2: The container transport system in the port of Rotterdam with possible money flows to a hub

After a thorough literature review in chapter 2 it is found that there is not enough, if any, research yet on how night-time container transport between port and hinterland by truck transport, using a hub with extended opening hours, should be designed to mitigate truck congestion at terminals' gates. That is because the focus of recent research within the freight distribution domain was more on shifting to intermodal transport. A lot of research has been written though on the urban distribution centers with night-time transport (e.g., van Duin et al., 2018; Estrada et al., 2018; Onstein et al., 2021). However, the urban distribution system is substantially different from the container transport system between ports and the hinterland. Thus, more research on the latter is needed. Dekker et al. (2013) has performed research on the implementation of a chassis-exchange with night-time container transport, but they made assumptions on the number of containers that would be transported via this extra hub instead of taking into account the decisions of all the actors involved. Also, a recent study from Sakai et al. (2020), that presents an agent-based freight simulation platform, states that further research is needed on modelling the real-life interactions between suppliers and receivers to evaluate new logistic solutions, which in this case would be the solution to facilitate night-time container transport using a hub with extended opening hours.

1.3. Objective

Next to the knowledge gap found in previous literature, the master thesis is a case study to mitigate truck congestion at terminals' gates in the port located in Rotterdam. The Port of Rotterdam has expressed that there is a need for research on how to design night-time container transport using a hub with extended opening hours. The reason for this is that actors in the container transport system are indicating the need for such a hub to spread the peaks at terminals' gates. However, the fact that actors in the system indicated the need for a particular solution, has in the past not always implied a successful implementation and use of the solution by all actors involved. Thus, before implementing a solution, it should be researched how this solution should be designed for it to be used by the actors successfully and create the desired effects.

The objective of this research is to evaluate the actors and their (inter)actions in the container transport system and to analyse the effects of designing night-time container transport using a hub with extended opening hours to mitigate truck

congestion at terminals' gates in several scenarios. Since the characteristics of the hub with extended opening hours are yet to be researched, whenever a hub is mentioned in this paper, the type of hub is not yet determined. The hub could be a location where containers are stacked and stored, but it could also be a chassis-exchange, where the chassis with containers are stored. Section 4.3.3 elaborates on these types of hubs. With the findings of the research, it will be known how night-time container transport using a hub with extended opening hours should be designed and what will be the effects of introducing such a hub between the port in Rotterdam and the hinterland. The findings of this research could also be used at other seaports that have a similar hinterland transport model as Rotterdam.

1.4. Research questions

To be able to fill the knowledge gap and to reach the goal of the research, a research question and several sub-questions are formulated. During the development of these research questions, the time, money, capabilities and data needed to answer these are taken into account. The main research question that will be answered in this thesis is the following:

How can truck congestion at terminals' gates be mitigated designing night-time container transport between port and hinterland using a hub with extended opening hours?

As argued in the first section of the methodology chapter (3.1), agent-based modelling is the method most suited for evaluating the actors and their (inter)actions and for answering the main research question of this research. Agent-based modelling is used to simulate autonomous actors with their (inter)actions to observe effects on a whole network. The steps for developing an agent-based model (which can be found in figure 3.1 in chapter 3) are used to set up the sub-questions that have to be answered to answer the main research question. The steps of the research that help answer the research question are shown in figure A.1 within appendix A. A sub-question is formulated for every step in this figure. The sub-questions in the research are the following:

1. What actors can make decisions about night-time container transport?
2. What influences each actor's decision that can lead to night-time container transport?
3. How can these actors' decisions and their interactions be modelled?
4. What are the possible waiting time gains at terminals' gates from facilitating night-time container transport between port and hinterland using a hub with extended opening hours in several scenarios?

After answering all these questions, conclusions and recommendations can be written on how a hub with extended opening hours with truck transport operates successfully and thus how it could be implemented in the port of Rotterdam, or other ports with a similar hinterland container transport model.

1.5. Methods

The research methods that are used to answer the research questions stated in the previous section are discussed in the section 3.2. The first two sub-questions of this research are being answered using literature, derived from the internet and the Port of Rotterdam, and by conducting semi-structured interviews with actors. Actors that will be interviewed are carriers, receivers, freight forwarders, terminals, the Port of Rotterdam and the Ministry of Infrastructure and Water management. Using the information from these interviews and agent-based modelling, actors' decisions and their interactions will be modelled. Lastly, agent-based modelling and discrete event simulation are used to create a simulation model and to analyse the effects on the waiting times at terminals' gates from facilitating night-time container transport between port and hinterland using a hub with extended opening hours in several scenarios. Examples of factors that could differ in these scenarios are the storage capabilities of the hub, the location of the hub, the amount of costs of using the hub and the type of hub it will be, for example, a chassis-exchange or an inland terminal that stores containers. The simulation is made in Anylogic, as this program supports both agent-based modelling as discrete event simulation (Borshchev, 2014). The modelling framework is created with the four-step transportation forecasting model. As explained in chapter 3, queueing theory and discrete choice modelling are used to set up the steps of the simulation modelling.

1.6. Report structure

In figure 1.3 the outline of the thesis report is given. First, chapter 2 includes a literature review on spreading truck arrivals to off-peak hours. The conclusions of this literature review have led to the research questions stated in the introduction. Chapter 3 is the methodology chapter, including the formulation of research questions based on agent-based modelling

steps, the chosen methods of this research and a modelling framework. Chapter 4 describes the container transport system to be researched. This is done by answering sub-questions one and two, with the use of literature research and the findings of actor interviews. The interviews are included in the appendices. Chapter 5 answers sub-question 3, by using the findings of the interviews and theory on agent-based modelling. This chapter discusses the development, validation and verification of every aspect of the (agent-based) simulation model. Furthermore, in chapter 6 the effects on waiting times at terminals' gates of facilitating night-time container transport using a hub with extended opening hours will be analysed in several scenarios. Furthermore, the operational time gain of trucks using the hub and the possible costs, revenues and profits of various actors investing in a hub are discussed. Lastly, chapter 7 includes the discussion, conclusion and recommendations for future research. In this chapter, the main research question on how truck congestion at terminals' gates can be mitigated by designing night-time container transport between port and hinterland, using a hub with extended opening hours, is answered.

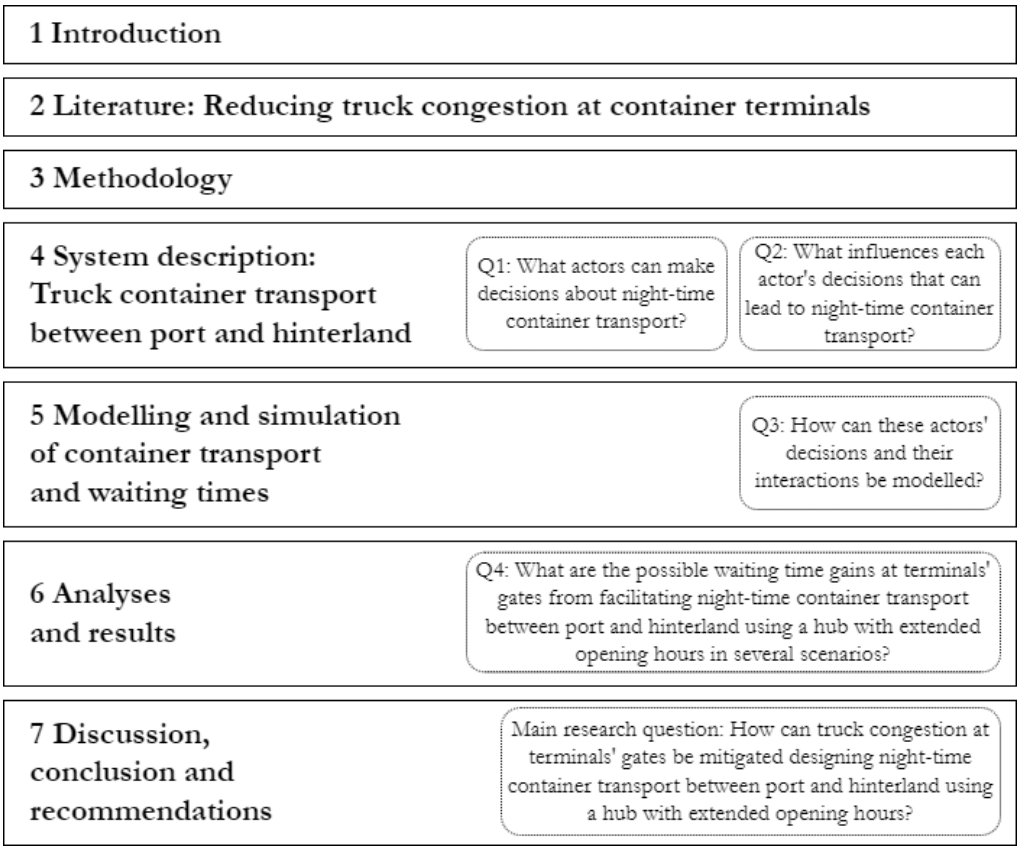


Figure 1.3: Outline of thesis report

2

Literature: Reducing truck congestion at container terminals

A container terminal at a seaport is the link between container transport at sea and container transport between the port and the hinterland. As can be seen in figure 2.1, a container terminal can be divided into three areas. These are the seaside, which is connected to container vessels, the yard, where containers are temporarily stored, and the landside, which is connected to trucks and trains that transport containers to and from the hinterland (Azab and Eltawil, 2016). The problem addressed in this thesis, that is truck congestion at container terminals, is located at the landside of a container terminal. In this problem, the capacity of the terminal operations can be seen as the supply, as they offer transhipment of containers to trucks. The number of trucks arriving at the terminal to deliver or pick up a container is the demand of this process. The long waiting times for trucks visiting container terminals during peaks hours signify that during those times, the demand exceeds the supply (Guan and Liu, 2009).

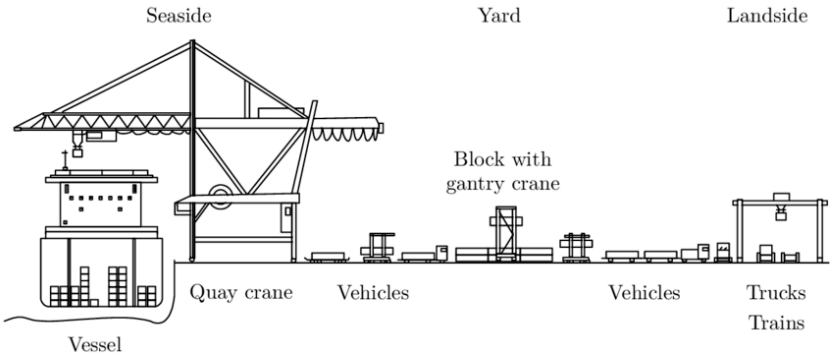


Figure 2.1: Schematic overview of a container terminal (Valls, 2017)

As mentioned in the introduction, possible solutions for reducing truck congestion at container terminals can be divided into three categories; (1) increase the supply, (2) decrease the demand and (3) better match the supply and demand. Firstly, the supply could be increased by enlarging the capacity of the container terminals. Secondly, the demand could be decreased by reducing the number of trucks arriving at the terminal. As the number of containers that have to be transported will not likely reduce in the future, this means the containers should be transported by other modes (like trains and barges) more often. Thirdly, supply and demand could be matched more efficiently by spreading truck arrivals to off-peak hours to better utilize the capacity of the terminal (e.g., Merk and Notteboom, 2015; Bentolila et al., 2016). This chapter includes a literature review that discusses the three possible solutions for truck congestion at container terminals using previous literature on these topics. Several search engines like Google Scholar, Scopus and the TU Delft library are used for this literature review.

2.1. Increase terminal capacity

According to Bentolila et al. (2016), the capacity of a terminal could be increased by expanding the physical capacity of the terminal or by decreasing the turnaround time of trucks at the terminals. The physical capacity of a terminal could be increased by developing additional gates and lanes to be able to supply more trucks arriving at the terminal. The turnaround time could be decreased using technological and managerial solutions that lower the total service time of the terminal. However, increasing terminal capacity is a limited solution. First of all, land for expanding the physical

capacity of the terminal might not always be available (Guan and Liu, 2009). Many seaports have space limitations and are restricting the future expansion of the existing terminals (Visser et al., 2007).

Furthermore, increasing terminal capacity will lead to even higher numbers of trucks that enter the terminal, which could lead to congestion in the terminal yard if the yard capacity is not adequate. Also, this solution will not resolve the underutilization of the terminal operations in off-peak hours (Guan and Liu, 2009). Moreover, according to Visser et al. (2007), redevelopment of the terminals does not reduce the road congestion on the infrastructure around the seaports, it merely makes this problem worse. Additionally, Giuliano and O'Brien (2007) and Giuliano et al. (2008) state that terminal operators do not care that much about the congestion in peak hours, as it means that their facilities are being used to the maximal amount. Thus, it will be hard to encourage them to enlarge or improve the container terminal. At the port of Rotterdam, terminals in the seaport are acknowledging the congestion problems, but are stating that this is not caused by the capacity of the terminals. They specify that there is enough capacity to transship all the containers, but trucks are not using all the capacity as they all visit the terminal during peak hours (Stroosma, 2020). At the port of Rotterdam, only 6.9% of the trucks are arriving at night (Smits and Zomer, 2021). Because of all the reasons stated in this section, this thesis will not focus on increasing terminals' capacities.

2.2. Decrease container transport by trucks

To decrease the demand for terminal operations, the number of trucks arriving at container terminals should be reduced. Since the volumes of international transport have only been growing, the number of containers that will arrive at and depart from terminals in the port of Rotterdam will most likely not decrease in the following years (Azab and Eltawil, 2016). Thus, to be able to decrease the number of trucks arriving at a container terminal, the containers should either use another terminal or a mode other than road transport. Rerouting the container via another terminal is not a solution to the problem as firstly, this is already easily possible and would have already been done by shippers. Secondly, in the port of Rotterdam, all container terminals that supply container ships are experiencing waiting times for trucks at their terminal gates (PortOfRotterdam, 2021b). Thus, a solution to decrease the number of trucks arriving would be to change the modal split at the landside of the terminals to more trains and barges. At this moment, the modal split for the container transport between the port of Rotterdam and the hinterland is 58% for trucks, 30% for barges and 12% for trains (BinnenvaartCijfers, 2017). For transporting containers to and from the terminals, intermodal hubs are needed. The reason for this is that barges and trains can rarely transport containers to the location of a customer in the hinterland. Another leg of truck transport is needed to complete the transportation between port and customer.

Because currently, the truck is not the most sustainable mode of transport, the European Union has been trying to promote other modes than road transport, like barges and trains, for years. This, and the fact that less road transport would lead to less truck congestion at container terminals has led to a lot of research on intermodal hubs and quite some implementations of these hubs (Merk and Notteboom, 2015). In Rotterdam for example, the ECT terminal has developed several intermodal hubs in the Netherlands, Germany and Belgium, that have a daily rail connection between the seaport and the gate (Roso and Lumsden, 2010). However, next to all the advantages that those modes and intermodal hubs are offering, various papers state there are also some downsides to container transportation by train and barge between seaports and a hub. According to Visser et al. (2007), barges and container trains both are large-capacity services that perform low frequent transport in large batches with low speeds. They state these might not be the most suitable attributes for the transport between seaports and a hub, as this transport needs to be highly reliable and on-demand. Furthermore, they state that the aim of the port of Rotterdam, to realise a modal split with a much higher share of rail and barge transport, will probably not be feasible because of the huge numbers of containers that would have to be transported on the rail and waterways. Other research is also questioning the efficiency of the use of modes like barges and trains and the gain of intermodal hubs for the actors involved. Moreover, also the transport via barges will only become more competitive if that transport has a high proportion of the total transport route. According to Meers et al. (2016) and Meers et al. (2018), an intermodal hub is not always more competitive than truck transport for short-distance transport operations. Especially when the containers are still transported by truck between the hub and the hinterland. Furthermore, the costs of the hinterland transport will only reduce if the transport between the hub and the hinterland is also done by other modes than trucks. However, road transport is likely to maintain its dominance for the transport between the hub and inland regions (Ng, 2009). Likewise, Merk and Notteboom (2015) state that container transport via the rail network only has a competitive advantage in the case of large distance transport.

However, origin-destination data from TomTom shows that on average 90% of the trucks that arrive at or depart from the large container terminals in the port of Rotterdam, drive from or to a location within the area called *Large Rotterdam*,

which can be seen in figure 2.2 (PortOfRotterdam, 2021c). Thus only the other 10% of the truck movements are between the containers at the seaport and the hinterland further away. As previous literature stated that intermodal transport has a competitive advantage in case of large distance transport, using trains and barges will in most cases not be more profitable for the actors that make mode choices for container transport. Furthermore, future developments on electric trucks for container transport may lead to the fact that road transport will not be more polluting than train or barge transport. Moreover, it might make container road transport even cheaper (LESAM International Group, 2021).

Figure 2.2: The area called *Large Rotterdam* (PortOfRotterdam, 2021c; GoogleMaps, 2021)

Doubts about the advantages and usage of intermodal transport in the literature can also be observed in the actual modal split over the years. At this moment, despite various policies by the European Union to promote intermodal transport, the market share of road transport has been increasing. In 2016, the truck share was 76% of the inland freight transport. Reasons for this could be the more liberalized markets, the removal of trade barriers and the growing economic activity in the east of Europe, that is not well connected by train transport (Behdani et al., 2020). Also at European seaports, as stated earlier, most containers are being transported between the seaports and the hinterland by truck, despite the possibility to use intermodal hubs. According to Meers et al. (2016), reasons that shippers and logistics service providers are choosing trucks over barges and trains are the speed of the transport modes, the possible frequency of the transport, the amount of service supply and the uncertain reliability and flexibility of barge and train transport. Furthermore, the actors involved in the decision of transport mode are the senders, receivers, transport operators and the shipping agent. They are all mainly costs driven and the costs of intermodal transport will not be lower than truck transport for short distances. Moreover, as, at this moment, there simply is not a lot of infrastructures built for short intermodal transport, terminals state that very few containers could be shifted to (existing) waterways and rail transport (PortOfRotterdam, 2021a). Building new water and railway infrastructures could be a solution to the lack of existing infrastructure for intermodal transport. However, implementing this is very costly and takes a lot of time (Motono et al., 2016). More short term solutions are needed as well in this present problem. Thus, the next section will focus on spreading truck arrivals at terminal gates.

2.3. Spreading truck arrivals

The third way to reduce truck congestion at container terminals is to better match the demand and supply. At the port of Rotterdam, all terminals are open 24 hours per day and 7 days per week, while almost all trucks arrive between 05:00 and 16:00 (PortOfRotterdam, 2021b) and only 6.9% of the trucks are arriving at night (Smits and Zomer, 2021). By moving the transport of containers between terminals and the hinterland to off-peak hours, the truck arrivals will be spread more evenly over a whole day and all capacity of the terminal can be used. The policies to stimulate this off-peak container transport can be divided into three categories; (1) restricting off-peak arrivals, (2) encouraging off-peak arrivals and (3) better facilitating off-peak arrivals. Restrictions for trucks about the arrival times could be done with the use of a truck appointment system, which will be discussed first. Secondly, encouraging trucks to arrive during off-peak hours using monetary incentives will be discussed. Thirdly, better facilitating off-peak arrivals by easing the present constraints of off-peak transport will be reviewed.

2.3.1. Restricting: Truck appointment system

The first policy to be reviewed, to spread the peaks of truck arrivals at terminals, is one where the truck distribution is being forced to move to off-peak hours because of restricting the number of truck arrivals at terminals. This can be done by implementing a truck appointment system (TAS), also called a terminal appointment system. A lot of research has been done on this policy. A truck appointment system lets terminal operators decide the maximum number of trucks

that can arrive at the terminal gate for each period of the day, which is called the appointment quota. Then, truck drivers can choose the period that they want to arrive at the terminal gate in advance if it is not full yet (Zhang et al., 2019). Because the number of arriving trucks is constrained per period of the day, they are forced to arrive at different hours. This ensures that the peaks will be spread over the whole day and there will be less congestion in the peak hours. Many researchers have claimed that implementing a truck appointment system at terminal gates is one of the most effective ways of reducing truck congestion, if the terminal has a high throughput of containers (e.g., Guan and Liu, 2009; Azab and Eltawil, 2016; Neagoe et al., 2021). Not only does much research recommend a truck appointment system to reduce the waiting times at terminals, but also the emissions released by idling trucks at the seaport have to be lowered. According to Li et al. (2018), a truck appointment system is a green initiative for the improvement of the terminals at the seaport, as the systems reduce the congestion at the terminal gates, which creates high emissions.

Next to much literature that highlights the advantages of a truck appointment system, there are positive examples in real life of the implementation of a truck appointment system. For example, the experiences in the port of Hong Kong were classified as successful for the reduction of waiting times in peak hours (Bentolila et al., 2016). However, not all implementations of a truck appointment system are successful. Giuliano and O'Brien (2007) and Giuliano et al. (2008) have evaluated the terminal appointment system that was implemented at the ports of Los Angeles and Long Beach. The reports conclude that there was no evidence of reduced waiting times at the terminals. There were several reasons why this system did not work successfully, such as the fact that the policy was not a response from within the industry, but it was imposed from outside. Also, the terminal operators were not interested in reducing the waiting times for truckers. According to Motono et al. (2016), a lot of the truckers did not understand the system well and it was not easy to go smoothly to your appointment if you made one. Furthermore, the truckers had to make an appointment at least 24 hours before their arrival. Since at that time they do not know the road congestion yet, they would often arrive at a different time than their appointment slot. Thus, they are not able to enter the terminal and have to book a new time slot, which could lead to several extra waiting hours. Also in the port of Rotterdam, two container terminals have implemented a truck appointment system; the APM terminal and the Rotterdam World Gateway (RWG). These systems have shortcomings too, according to the truck drivers. Some truck drivers are already making their appointment 3 days before their arrival, which makes it difficult for other truck drivers to plan their container trips. If for example the only free slot is left at 16:00 on a day that they have picked up and delivered another container in the morning, they have to wait several hours before they can make a trip again. Furthermore, if they miss their time slot because of road congestion, they often have to wait several hours in front of the terminal, which leads to high costs (Rijnmond, 2020).

Because of the several unsuccessful implementations of truck appointment systems, research has been investigating the shortcomings of existing appointment systems. Huynh et al. (2016) discusses the most common issues found in the industry and literature. The shortcomings they discuss are the insufficient possible appointments given by the terminals, the lack of flexibility and the lack of a reset option, the inability for truck drivers to fulfil their second/afternoon appointments, the lack of transparency, the vulnerability to manipulation, the lack of standardization and the lack of motor carrier input. According to Merk and Notteboom (2015), forcing trucking companies to move to off-peak distribution causes problems because of the requirements and restrictions of cargo owners and the operations of elements in the supply chain like the opening hours of distribution centres, that only work during the day. Thus, truck drivers and other actors in the container distribution network are not always pleased with the restriction of the number of trucks arriving in peak hours and the implementation of a truck appointment system leads to several problems and challenges. To try to remove some of the irritations and make off-peak arrivals more attractive, truck appointment systems are sometimes combined with pricing systems to encourage off-peak arrivals of trucks at terminal gates (Bentolila et al., 2016).

2.3.2. Encouraging: Monetary incentives for off-peak transport

A solution to spread the peaks of trucks arriving at terminal gates without introducing restrictions is encouraging truck arrivals in off-peak hours with monetary incentives. These off-peak arrivals can be promoted by awarding incentives to trucks with off-peak arrivals and/or by charging a fee to trucks that arrive during the day (Bentolila et al., 2016). By successfully promoting off-peak distribution, more and more truck drivers will move their arrival times to off-peak moments, like nights and weekends, if terminals are open at these times. Because of this, the peaks at the terminal gates will be spread and congestion at container terminals will be reduced. Promoting off-peak deliveries in all kinds of sectors is something that has been done for a very long time, and a lot of research is done on this topic.

Various papers present the benefits of night-time distribution for several actors. Trucking companies, which are the logistics service providers and are also being called carriers, gain the most benefits from distribution in off-peak hours and are very interested in performing these off-peak deliveries, even without monetary incentive (Verlinde et al., 2010).

The main reason for them to want to move their operations to the night-time is the reduction in time spent at the port because of less waiting time during off-peak periods. These faster turn-around times will lead to faster deliveries and thus lower costs and more efficient transport (Holguín-Veras et al., 2005; Holguín-Veras et al., 2008). According to Gnap et al. (2017), the truck's idle speed during off-peak hours is on average 31% faster than during the peak hours in the morning. Moreover, the speed of the road network is on average nearly 60% higher than during the peak hours in the afternoon. Furthermore, previous papers are not only focusing on the benefits of night-time distribution for logistic service providers, but also the external utilities that appear because of night-time distribution. Since more transport will be performed at off-peak hours, the road congestion will reduce. This leads to several benefits, which are the time saving for other road users, the enhanced road safety and the reduction of emissions and air pollution (Bentolila et al., 2016; Gnap et al., 2017).

Even though the trucking companies and other actors are seeing a lot of benefits in the implementation of off-peak distribution, promotion of night-time distribution is often not implemented successfully. Bentolila et al. (2016) have written a paper on a night-time distribution program that has been implemented on the port of Haifa, in Israel. In the program, importers and exporters that were transporting containers between 10 pm and 6 am received a monetary incentive. After the research, the paper concludes that the program is not effective enough as there is no significant increase in off-peak distribution and that more effective methods should be researched. The paper gives several explanations of truckers on why they are still arriving at the container terminals within peak hours. First of all, the cargo-owners had too specific demands and requirements. Secondly, the opening hours of the destinations of containers, like distribution centres, that regularly imply that containers can only be picked up and dropped off during the day, lead to problems. Furthermore, some countries ban trucks from the road network during the weekend. Lastly, the legal labour restrictions about when truck drivers should rest during night work could sometimes be a reason not to perform off-peak deliveries. After an examination of the logistic chain, the paper discusses three reasons why the landside transport of containers is limited to the daytime. Firstly, most firms are only receiving goods during the day. Moreover, empty container parks are only open during the day, which makes it hard to make efficient combining trips at night. Furthermore, trucking companies are working with 12 hours shifts, because of legal restrictions on driving hours. Altogether, even though there were enough incentives for truck companies for night-time distribution, they were often not able to perform these kinds of off-peak deliveries.

Other papers that also investigated policies that were promoting off-peak distribution, found the same kind of explanations from truckers on why they were not performing off-peak deliveries. According to Holguín-Veras et al. (2005), the main reasons to keep performing deliveries during the peak hours are that customers are not accepting off-peak deliveries, businesses are not open during off-peak hours and there are higher employee costs during the night. Other reasons are the extra usage of equipment and machinery, the extra costs of security, community complaints about noise at night, union issues, time-sensitive cargo, zoning restrictions and the negative impact on competitiveness. These researchers are not the only ones stating that the most decisive success factors of night-time distribution are the attitude of the receivers and that only giving incentives to carriers will not work (Holguín-Veras et al., 2007; Holguín-Veras et al., 2008; Verlinde et al., 2010). Research has found that only 9% of the carriers that received a toll increase were able to pass it to their customers, because of the lack of their market share (Holguín-Veras et al., 2008). Also, they conclude that even in those cases, the increased costs were not a sufficient incentive for receivers to accept off-peak deliveries. As receivers have huge influences on the actions of carriers, if they would request off-peak deliveries, carriers will probably do it. If these receivers, like delivery hubs, would for example be staffed by robots, as Nowak et al. (2018) are thinking it will be in several years, it would be easy for them to accept night-time distributions. However, that is not the case at the moment, so reasons of receivers not to accept night deliveries should be taken into account. Several papers are investigating why receivers are not interested in off-peak distribution. The main reason for them not to accept off-peak deliveries are the fact that they would have to extend their working hours and pay their employees extra to work at night (Holguín-Veras et al., 2007; Holguín-Veras et al., 2008; Verlinde et al., 2010).

2.3.3. Facilitating: Ease constraints of off-peak transport

As the previous sections made clear, the main reason why truck appointment systems and monetary incentives for off-peak distribution have implementation issues is that receivers will not accept off-peak delivery. This problem is seen as the main constraint of off-peak container transport by the literature. This section will elaborate on possibilities to ease the constraints of off-peak transport.

Extend opening hours at receivers
Convincing receivers of containers in the hinterland, like distribution centres, to accept containers at night is an obvious solution that comes to mind for this problem. However, many parties have tried to convince these companies to extend their opening hours so trucking companies can extend their processes and waiting times could be reduced. Until now, very little receivers have agreed with this, as this comes with high costs for them (Smits and Zomer, 2021; PortOfRotterdam, 2021a). Thus, other possibilities to facilitate off-peak transportation of containers should be investigated.

Hub with extended opening hours
For a solution to facilitate off-peak arrivals at terminals, even though receivers in the hinterland do not want to accept off-peak arrivals, literature on urban deliveries could be analysed. Holguín-Veras et al. (2008) discuss the idea of a central receiving station where deliveries can be made during off-peak hours and the deliveries to the end receivers will still be done during normal working hours. They state that implementing such a central receiving station will be successful in areas with a lot of deliveries and that carriers will benefit as there would be less transport during congested peak hours. However, the paper mentions that it would be hard to find suitable land to create a central receiving station within urban areas. Furthermore, the usage of such a station at night can lead to noise complaints from people living in these residential areas. Research has been done on the amount of noise coming from loading and unloading actions. It has been found that a lot of the time, these actions exceed the noise standards of residential areas, which are 65 dB between 7 pm and 11 pm and 60 dB between 11 pm and 7 am (Gnap et al., 2017). Because this research is focusing on container transport between the seaport and the hinterland rather than cargo distribution in urban areas, the scarcity of suitable land for introducing such a station, in this case, would potentially be less of a challenge. However, the location of such a station should be taken into account, so that it would not be implemented in a residential area and no noise standards will be exceeded. Within container transport between a seaport and its hinterland, a concept comparable to a central receiving station, is called a hub. A hub with truck transport to and from the seaport could spread the peaks of truck arrivals at container terminals by extending its opening hours to the evening and night-time. The idea of a container hub could be that trucks transport containers between the seaport terminals and the hub during off-peak hours (like evenings, night-time and the weekend), to reduce the congestion at the terminals. Then, the containers can be transported between the hub and the hinterland during the normal daytime, to comply with the working hours of receivers like distribution centres. Another possibility of a hub with extended opening hours is a chassis-exchange, where not only the containers are stored, but the chassis, with the container on top, is stored at the hub to be transported to the customer in the hinterland during working hours. Even though a hub with extended opening hours sounds like a promising solution, several challenges appear when thinking about the implementation of such a hub. As discussed in this literature review, because of the night-time container transport between the seaport terminals and the hub, elements like the legal restrictions of trucker working hours, costs of operating the hub at night and the location of the hub with night operations and noise should be taken into account.

Furthermore, various papers state that the quality of hinterland transport and inland access of seaports is a very complex challenge, as so many different actors are involved in the seaport-hinterland container system (e.g., de Langen and Chouly, 2004; van den Berg and de Langen, 2015; Behdani et al., 2020). According to these sources, this challenge has a large inter-organisational component because it depends on the behaviour of a lot of different actors, like freight forwarders, shippers, transport operators, port authorities and terminal operators. Although they are all mainly cost-driven, the actors all have different things that they find important. They state this leads towards a *collective action problem* where coalitions are necessary for improving the hinterland transport. Furthermore, according to the research of van Duin et al. (2018), shippers and logistics service providers sometimes act contradicting their beliefs. This makes it even more difficult to know how to implement a solution to a challenge within the hinterland container system. When implementing a hub with extended opening hours to reduce truck congestion at terminal gates, the successful operation of such a hub is completely dependent on the behaviour of all the actors involved in the hinterland container transport. For determining the characteristics of a hub with extended opening hours (e.g., type of hub, location, capacity and costs), it should be known under what conditions a hub will be attractive for the actors that are involved in the decision whether to actually perform night-time container transport and make use of the hub. According to Visser et al. (2007), it remains uncertain how merchant haulage transport will react to a possible implementation of a container hub. Moreover, Veenstra et al. (2012) state that one of the main challenges of the implementation of a hub or extended gate is the selection of the characteristics and requirements to make sure that it is included in the hinterland network by the actors involved.

However, since a hub with extended opening hours with truck transport between a seaport and the hub is quite a specific and a rather new concept, not a lot of research is done on the characteristics of such a container hub to be attractive to actors and to work successfully. Behdani et al. (2020) have performed a very extensive literature review on the emerging

trends in port-hinterland transport. This paper shows that frontier research is mainly focusing on the shift to intermodal transport instead of hubs with truck transport and night-time container transport. In the area of urban distribution centres, a lot of research has looked at deliveries that are transported by night to the distribution centre and are afterwards distributed to the customers during working hours (e.g., van Duin et al., 2018; Estrada et al., 2018; Onstein et al., 2021). However, the challenge of container distribution between seaports and the hinterland with all its actors is substantially different from this situation, so research in this area is needed. Research by Visser et al. (2007) analyses a lot of different modes for the transportation of containers between seaports and an extended gate, except for the usage of regular trucks. The reason they state is that road transport will not be reliable due to congestion. However, in the case of night-time transport, there would be no road congestion, which makes this concept possible.

An example of research that is closely related to the hub with extended opening hours is the research of Dekker et al. (2013). They focus on the implementation of a chassis exchange terminal to reduce the congestion at terminals in the port of Rotterdam, which could be a possible practice to implement a hub with extended opening hours. However, this research assumes a certain number of containers that will be transported via the extra terminal to calculate the gains and costs of the chassis-exchange terminal. It does not take into account the choice of actors to actually perform night-time transport and transport containers via this hub. In recent research, an agent-based transportation simulation platform called SimMobility Freight is developed, to evaluate novel logistic solutions and measure their impacts (Sakai et al., 2020). However, they state that the modelling method does not yet include interactions between suppliers and receivers that replicate the real-life simultaneous demand and supply decisions of these actors. Further research on these interactions is needed to evaluate new logistic solutions like implementing a container hub with extended opening hours.

2.4. Conclusion

This chapter has given a literature review on reducing truck congestion at container terminals in seaports by investigating the demand of trucks arriving at terminals exceeding the supply during peak hours. First of all, the supply of the terminal could be increased by enlarging the physical terminal capacity or by decreasing the turnaround time of trucks visiting terminals. However, this is a limited solution as terminals can not always increase their capacity anymore. Moreover, doing this could lead to more congestion in the terminal yard and on infrastructure around the port. Furthermore, terminals are not interested in increasing their capacity as they state that the capacity would be sufficient if trucks would not all arrive at the same time. The demand for trucks arriving at terminals could decrease by increasing other transport modes like trains and barges, which the European Union has been promoting in the last years. However, new infrastructure for intermodal transport is a costly solution and trains and barges only have a competitive advantage in the case of large distance transport. As most trucks visiting the terminals come from or go to areas close to Rotterdam and truck transport is much more flexible and reliable at the moment, the market share of road transport is not decreasing and will probably remain high in the future. Thirdly, the demand and supply could be matched more efficiently by better spreading truck arrivals over the whole day. As stated in this review, a lot of previous literature has pointed out the benefits of spreading the truck arrivals to off-peak hours.

Firstly, literature on spreading the peaks by restricting the number of trucks arriving in peak hours, with the use of a truck appointment system, is discussed. Even though this has been implemented successfully in some cases, there are also unsuccessful implementations, many frustrated actors and challenges to be faced to move the arrivals to off-peak hours. Secondly, literature on establishing spreading the truck arrivals by promoting off-peak transport with monetary incentives is discussed. Although trucking companies are very interested in off-peak container transport, especially with monetary incentives, the implementation of off-peak transport is often unsuccessful. The main reason for this is that receivers of containers in the hinterland do not accept off-peak deliveries, as they do not want to work during the night. Thus, research is needed on solutions to better facilitate off-peak transport and relax those constraints. A possible solution for this challenge that has received rather little research in the past is the implementation of a hub with extended opening hours. Previous research has focused mainly on introducing intermodal hubs. However, because these are costly, take a long time to be built and the advantages of truck transport ensure that shippers and carriers would also still want to use truck transport in the future, research is also needed on hubs with truck transport. The number of diverse actors with different behaviours that are involved in the container hinterland transport make sure that implementing such a concept is a complex challenge. Research is needed on the actions of and interactions between the various actors and the characteristics of night-time container transport using a hub with extended opening hours that ensure that actors will actually use this hub and the waiting times at terminals can be reduced. The conclusion of this literature review is a motivation for the research of this thesis.

3
Methodology

Chapter 3 discusses the methodology of this thesis. Firstly, the choice of agent-based modelling as a method for this research and for formulating the sub-questions of this thesis is given. Secondly, the choice of research methods to answer the research questions and the steps within these methods are explained. Furthermore, a modelling framework is given.

3.1. Main research approach: Agent-based modelling

To be able to reach the research objective and to know when a hub with extended opening hours is attractive for the actors involved and thus will be used, all the behaviours of actors and the interactions between them should be modelled. These are defining features of an agent-based simulation model (Macal and North, 2014). Agent-based models (ABM) are used to simulate autonomous agents with their actions and interactions to observe the effects on the whole network, instead of traditional models that only simulate system-wide behaviours. The agents make decisions based on rules that are given to them (Robertson, 2005; Anand et al., 2016). According to Macal and North (2006), the first characteristic of agents is that an agent is identifiable and has clear boundaries to determine whether a specific characteristic is part of an agent. Secondly, an agent is situated in an environment with other agents with which it interacts and it has the ability to respond to the environment. Furthermore, an agent may be goal-directed, so it can compare the reaction of its behaviour to its aim. Moreover, an agent is self-directed, autonomous and can operate independently. Lastly, an agent is flexible and has the capability to learn.

Aside from agent-based modelling, other methods to simulate the container transport system could for example be systems dynamics and discrete event simulation. However, after analysing these methods, it can be stated that agent-based modelling has some advantages for the problem tackled in this research. According to Macal and North (2009), the main advantage agent-based modelling has on other simulation approaches like systems dynamics and discrete event simulation is that it takes into account well-defined behaviours and decisions of actors, dynamic strategic interactions and relationships between actors and the spatial components of actors. Moreover, another advantage of these models is that they do not require to always be in equilibrium, as opposed to economic models. Furthermore, agent-based modelling can take the bounded rationality of actors into account, which is very interesting for real-life situations where actors are also not always rational. However, there are of course also drawbacks to this method. For example, the fact that whenever the model does not have an equilibrium, not *one solution* can be found. However, since the real world is *messy*, this can also be seen as realistic. Another limitation of agent-based modelling is that depending on the complexity and number of interactions modelled, there are practical limitations on the number of agents that can be modelled on a regular computer (Robertson, 2005). Thus, boundaries will have to be set to create a feasible model.

Despite some limitations of agent-based modelling, agent-based modelling is still considered a method well-suited to simulate the reality and answer the main research question stated in section 1.4. The main reason for this is the many actors involved in the container transport network between the port of Rotterdam and the hinterland, and the fact that actions of and interactions between them are very important to study the characteristics of a night hub with truck transport. Also looking at previous research that tried to simulate the freight distribution most realistically, agent-based modelling seems a fitting method. According to Gusah et al. (2019), because of the big number of actors involved in the distribution of freight, agent-based modelling is a popular method in many papers to simulate the freight supply chain. Examples of agent-based freight simulation models are FREMIS, the MASS-GT framework and SimMobility Freight (Cavalcante and Roorda, 2013; de Bok and Tavasszy, 2018; Sakai et al., 2020).

When simulating the container transport in this research, agent-based modelling can also be combined with other methods like discrete event simulation. However, when creating the sub-questions of this research, it is important to focus on

the main steps of agent-based modelling, as this method is the most suited to evaluate the actors and their (inter)actions in the container transport system and to answer the main research question of this research. In figure 3.1, the steps of setting up an agent-based model are shown. These steps are being used to formulate the sub-questions of this research in section 1.4.

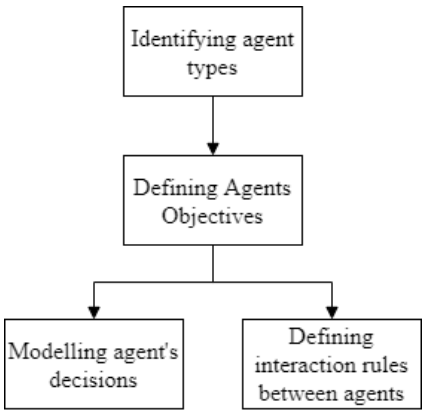


Figure 3.1: Agent-based modelling steps (based on Son et al., 2014)

3.2. Research methods

Figure 3.2 shows the research methods for answering every sub-question of this research. To determine what actors can make decisions about night-time container transport and what influences each actor's decisions that can lead to night-time container transport, literature research and semi-structured interviews with actors are conducted. The literature research includes literature from the internet and the Port of Rotterdam. Furthermore, these interviews and the theory behind agent-based modelling will lead to the modelling of the actors' decisions and their interactions. Lastly, agent-based modelling and discrete event simulation are used to answer the fourth sub-question and analyse the possible waiting time gains at terminals' gates from facilitating night-time container transport between seaport and hinterland using a hub with extended opening hours in several scenarios. The sections below elaborate on the several research methods used in this thesis and how agent-based modelling and discrete event simulation can be combined.

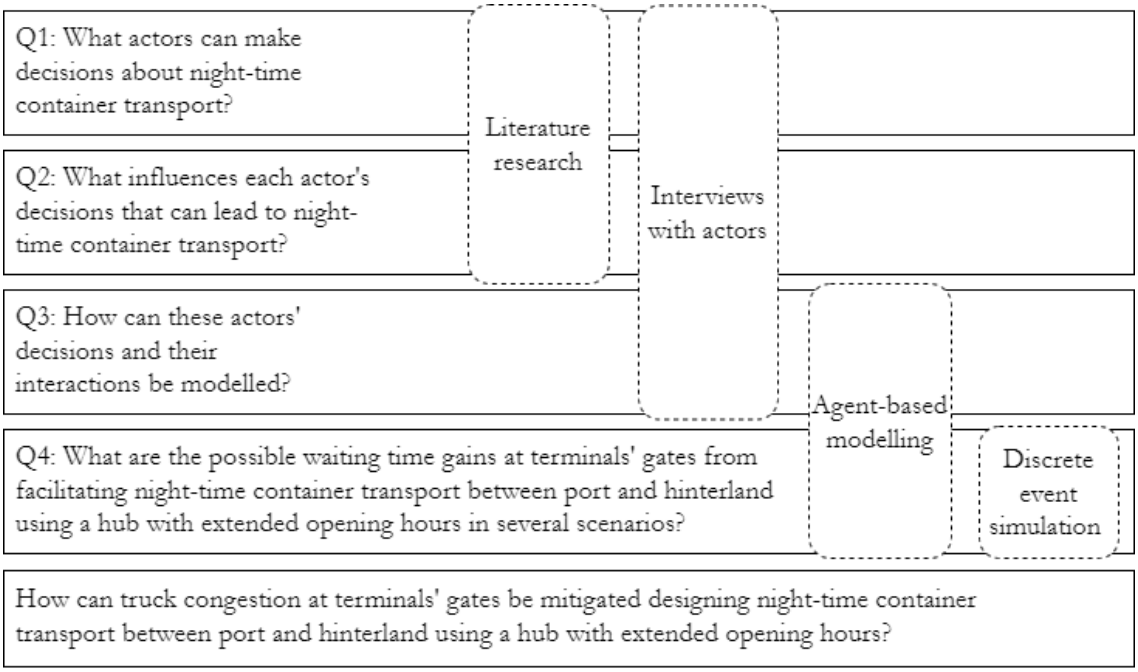


Figure 3.2: Methods for answering research questions

3.2.1. Literature research

As container transport between port and hinterland has already been analysed in the past, literature research is conducted to determine what actors can make decisions about night-time container transport and what are the influences of each actor's decisions that can lead to night-time container transport. The literature research uses scientific literature from search engines on the internet and literature provided by experts from the Port of Rotterdam. The latter might not be scientific articles, but expert knowledge of the subject. With the use of this literature research, together with the interviews with actors, chapter 4 is written to describe the system researched in this thesis. Using the literature research, graphs with all factors that influence decisions about night-time container transport and about using or investing in a hub with extended opening hours, are made for every actor (appendix D). One large graph of all decisions that lead to performing night-time container transport and using a hub, and all factors that influence these decisions is created and shown in chapter 4 (figure 4.1). Interviews with actors have afterwards validated and modified these graphs.

3.2.2. Interviews with actors

After the literature research, interviews will be conducted to validate and adjust assumptions, as is done by Gusah et al. (2019), about what actors can make decisions about night-time container transport and what are the influences of each actor's decisions that can lead to night-time container transport. With the use of these interviews, the graphs in appendix D and figure 4.1 are updated to fit the real situation. The interviews with actors will also be used to identify the interactions between actors. Conducting interviews is a method of collecting qualitative data for research (Carter and Little, 2007). The reason for choosing this method for answering the first three sub-questions in this research is that it focuses on the reasons why actors make decisions, rather than only focusing on what happens in the current system. Methods like conducting surveys focus on more quantitative data and do not include the possibility to ask more in-depth follow-up questions. Furthermore, surveys need a lot of respondents, which is not easy in this research field. Thus, conducting interviews with several important actors that are involved in this research field, is the solution to gather the needed information for answering the first three research questions.

Interviews can be divided into three categories; structured, semi-structured and unstructured. For conducting the latter, the interviewer needs a lot of training and expertise (Carruthers, 2007). Furthermore, an unstructured interview is not convenient for this research, as clear answers are needed for some rather closed questions, which are hard to be obtained from unstructured interviews. In structured interviews, all questions are closed and there is no possibility to let the interviewee talk about their opinion on something, which is also not convenient for understanding the thoughts and influences of all actors. Semi-structured interviews give the possibility to let the conversation flow naturally by the wish of the interviewee while being able to come back to the prepared questions that need an answer. According to Carruthers (2007), semi-structured interviews work best when the respondent knows the intention of the interview, when total anonymity is guaranteed and when the questions are properly worded. Personal contact is the easiest way to meet these conditions. However, because of the current work situation due to the coronavirus, all interviews were conducted online via Teams video calls. The actors that are interviewed were contacted through relations of people working at the Port of Rotterdam and are employees working at several carriers, receivers, freight forwarders, a terminal, the Ministry of Infrastructure and Water Management and the Port of Rotterdam itself.

3.2.3. Agent-based modelling

With the conclusions of the literature research and the semi-structured interviews with actors, agent-based modelling is used as a method to model all actors involved in the system with their (inter)actions. The reason for choosing agent-based modelling and the important aspects of this method are discussed in section 3.1. Agent-based modelling focuses on identifying agent types, defining agents' objectives and modelling agents' decisions and the interaction rules between agents (Son et al., 2014). A conceptual agent-based model will be created after the literature research and interviews, containing all actors involved, the actions leading to night-time container transport and the interactions between these actors. With the use of this agent-based model, together with discrete event simulation, the container transport system and its actors can be simulated to answer the fourth sub-question. This will be done in the program Anylogic. This program is suited for agent-based modelling, discrete event simulation and system dynamics (Borshchev, 2014).

3.2.4. Discrete event simulation

The fourth and last research method that will be used in this thesis is discrete event simulation. Discrete event simulation is a method to quantitatively represent the real world. The real worlds dynamics are simulated on an event-by-event basis (Goti, 2010). Discrete event simulation can provide a clear overview of how a process operates, where queues form and how proposed improvements might affect the performance of the whole system. Compared to system dynamics, its main competitor, discrete event simulation fits the research questions of this thesis better, as the transportation of containers

can be seen as a clear process where every action is an event, the queues formed at terminals are important to simulate for analysing the waiting times and the introduction of a hub with extended opening hours will affect the performance of the whole system. Furthermore, system dynamics is better suited for continuous processes that change over time where feedback substantially affects the system's behaviour, which is often chosen as the tool for a training vehicle (Sweetser, 1999). As stated by Majid et al. (2016), combining discrete event simulation and agent-based modelling can improve the performance of the simulation of service systems with human behaviours. Pawlewski et al. (2013) also considers the combination of agent-based modelling and discrete event simulation valuable to solve planning and managing problems. As stated before, Anylogic is a program that provides the creation of a simulation model with both agent-based modelling and discrete event simulation (Borshchev, 2014). The actions of each actor will be modelled and their interactions and the processes of the whole system will be simulated with the use of queueing theory and discrete choice modelling. First, the current real-world situation is simulated. After that, the introduction of night-time container transport using a hub with extended opening hours is simulated in several scenarios. The effects on the actors' decisions and thus on the waiting times at terminals' gates can be analysed in several scenarios of implementation. What the several scenarios will be, will be discussed in section 4.3.3.

3.3. Modelling framework

When using agent-based modelling and discrete event simulation to create a model that simulates real-world container transportation and evaluates the effects of introducing a hub with extended opening hours, transport is being forecast in several scenarios. The primary tool for forecasting the performance of a transportation system is the four-step model. This four-step model is created to deal with the complexity of transport networks and consists of the following steps: trip generation, trip distribution, mode choice and route assignment (McNally, 2007). As this research is only focused on truck transport, the mode choice can be excluded from the model. All the other steps can be found in the modelling framework made for this research, shown in figure 3.3. The bold text is the available data that is the input for the model. The dotted lines signify that the actions of this arrow are only being executed once.

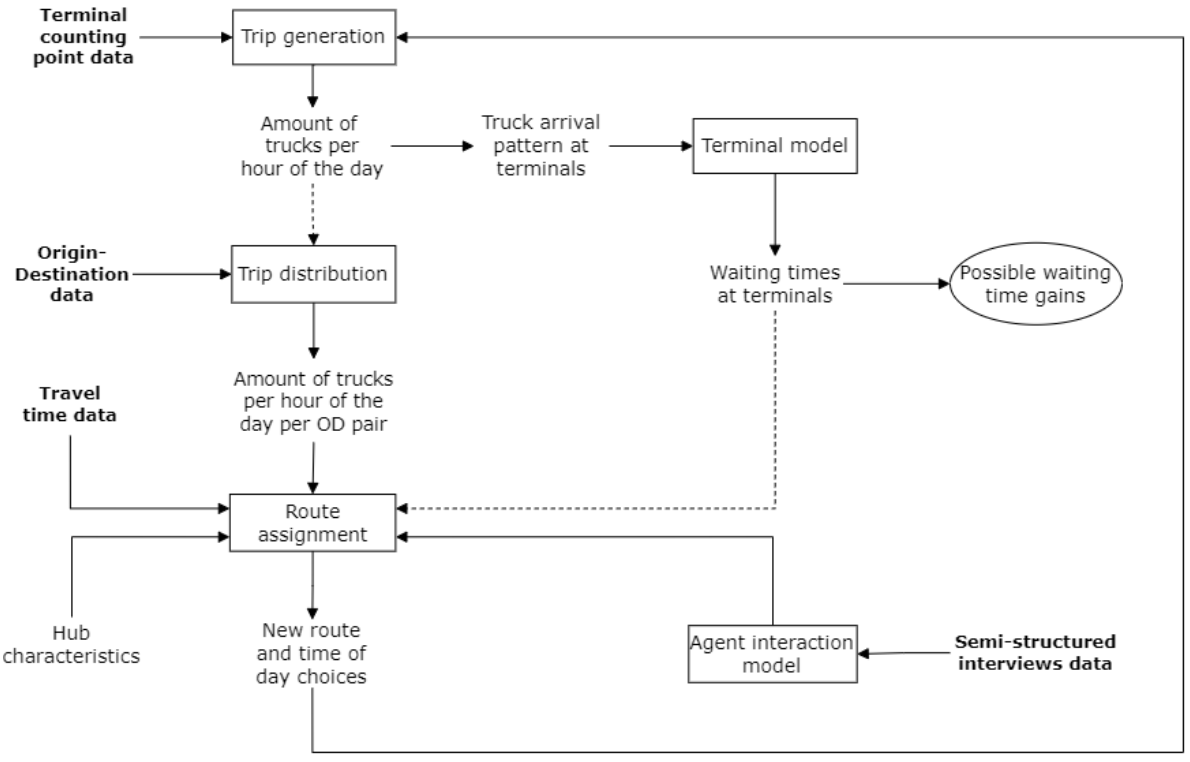


Figure 3.3: Modelling Framework

As can be seen in figure 3.3, data from counting points located in front of each terminal is used for the generation of trips, which is the first step of transport forecasting. When the number of trucks that arrives at each terminal per hour of the day is known, this arrival pattern is the input for the terminal model. For this component of the modelling framework, queueing theory is used.

Queueing theory
The terminal model is a multi-server queueing model (M/M/c) that calculates the waiting times of the trucks at the terminals' gates, based on the arrival pattern, service time and the number of servers. The basic queueing formulas that are used within a queueing model can be found below (Gosavi, 2021). These formulas describe the expected number of trucks in the queueing system (L), based on the mean arrival rate (λ) and the *waiting* time in the whole system (W). Furthermore, the expected queue length (L_q) is dependent on the waiting time in the queue (W_q). Lastly, to calculate the waiting time in the whole system from the waiting time in the queue, the mean service time is used (μ).

$$L = \lambda * W \tag{3.1}$$

$$L_q = \lambda * W_q \tag{3.2}$$

$$W = W_q + \frac{1}{\mu} \tag{3.3}$$

The second step of transport forecasting is trip distribution. Origin-Destination data that is obtained from TomTom-data is used to determine the average number of trucks per hour of the day per OD pair. This, together with the waiting times at terminals, travel time data, the characteristics of a possible hub with extended opening hours and the agent interaction model, is input for the route assignment. The agent interaction model is built by answering sub-question 1, 2 and 3 of this research. The semi-structured interviews that are conducted, together with the literature research, give inside into what actors are involved in the decisions on night-time transport, what are the influences of their decisions and what are their interactions. How these actors (inter)act is important to be able to know how trucking companies for example plan their tours, when they would travel at night and when they would use a hub with extended opening hours.

Discrete choice modelling
In the route assignment block of the modelling framework, actors decide whether or not to use the hub with extended opening hours. Factors like the waiting times at terminals, travel time data, the characteristics of a hub and details on agent interactions play a role in this decision. When modelling decisions of people, a discrete choice model (DCM) has to be taken into account to forecast the behaviours of actors. A suitable choice model for this research is the multinomial logit model (MNL). Section 7.1 discusses the choice of this model. The formulas of a multinomial logit model, that assumes that the random error terms of the utility functions of discrete choice models follow an independent and identically distributed (IID) type 1 extreme value (EV) distribution across alternatives, choice situations and individuals, with a variance of $\frac{\pi^2}{6}$, are stated below (Chorus, 2019). These formulas describe the probability (P_A) that actors will choose alternative A over B, based on the observed utilities (V_i) of these alternatives. The observed utilities are dependent on the attribute value (x_{mi}) of attribute m, the preference parameter (β_m) of attribute m and a possible alternative specific constant (ASC_i).

$$P_A = \frac{e^{V_A}}{e^{V_A} + e^{V_B}} \tag{3.4}$$

$$V_i = ASC_i + \sum_m \beta_m * x_{mi} \tag{3.5}$$

When all factors are taken into account and the tours with the highest probability are calculated, the route assignment will lead to new route and time of day choices. The latter change, because when a hub with extended opening hours is used, the time of day of the container transport would change from some time during the day, to some time at night. These new time of day choices lead to new trip generation and truck arrival patterns at terminals. By recalculating the waiting times after new tours are planned, the possible waiting time gains can be calculated for several scenarios. Chapter 4 describes the container transport system and its actors, to set up the gathered information for the agent interaction model. Furthermore, it describes the hub characteristics in the scenarios to be modelled. Chapter 5 includes the data preparation and modelling of all elements in the modelling framework.

4

System description: Truck container transport between port and hinterland

This chapter will describe the system that is researched by firstly analysing the actors involved in container transport between the port and the hinterland, using literature on this topic, expert knowledge and semi-structured interviews with experts in the container transportation field. This answered the first sub-question of this thesis (*What actors can make decisions about night-time container transport?*). To answer the second sub-question of this thesis (*What influences each actor's decision that can lead to night-time container transport?*), the decisions and the factors that lead to the decisions of these actors are researched. To do this, all the processes in the container truck transport system between port and hinterland are analysed, using literature research, expert knowledge and interviews with the actors involved in this container transport. Interviews were held with several trucking companies, receivers, freight forwarders, a terminal operator, the Port of Rotterdam and the Ministry of Infrastructure and Water Management. The interview questions can be found in appendix F and the answers of the interviewees are given in appendix G. Following all the processes, the influences of decisions about night-time transport are discussed. Lastly, the introduction of a hub with extended opening hours in this system is described.

4.1. Actors involved in the transport

The literature review in chapter 2 has shed light on the complexity of the container system, as so many different actors are involved in the transport of containers between the seaport and the hinterland (de Langen and Chouly, 2004; van den Berg and de Langen, 2015; Behdani et al., 2020). Previous research on container transport has often only taken into account trucking companies and shippers to make the system easier (e.g., Cavalcante and Roorda, 2013). However, when investigating the real processes of container transport and reading more about this field in previous literature, it becomes clear that more actors are important for decisions within the container transport between the seaport and the hinterland (e.g., de Bok and Tavasszy, 2018). Thus, literature and knowledge of experts in the field are used to select various actors that can make decisions that can lead to for example night-time container transport and the use of a hub with extended opening hours between the seaport and the hinterland. Interviews with the selected actors have validated the actors involved in this container transport. The following actors are involved in operational decisions of container transport between the terminals in the port of Rotterdam and the hinterland:

1. Trucking companies (trucking companies that transport containers for shippers/freight forwarders)
2. Shippers (receivers/senders of containers from/to port that arrange the transport or use freight forwarders)
3. Freight forwarders (that arrange the transport by a trucking company for a shipper)
4. Terminal operator (of container terminals in the port of Rotterdam)

Other actors that do not play a role in the operational decisions of container transport but can play a role in the implementation of solutions to reduce waiting times at terminals are the following:

5. Port of Rotterdam
6. Government (Ministry of Infrastructure and Water Management)

Interviews with these actors, which can be found in appendix G, confirm this list of actors to be involved in the container transport between the port of Rotterdam and the hinterland. The following sections will elaborate on what these actors do precisely and how they make decisions that could lead to night-time container transport.

4.2. Container transport by truck between port and hinterland

This section will shed light on how the container transport system works between the port of Rotterdam and the hinterland by truck. It discusses container transportation in chronological order. The information for this has been gathered by literature on this topic, expert knowledge and mainly by the interviews with various actors involved in this system (appendix G) and experts in the field.

4.2.1. Long-term agreements between actors

Shippers within the scope of this transport system are companies that are receiving and/or sending containers from and to terminals in the port of Rotterdam by truck. They can arrange the transport of containers between the terminals and their location themselves by making agreements with trucking companies that transport containers. However, many shippers choose to outsource these activities to freight forwarders, which will make these agreements with trucking companies for them. The agreements trucking companies make with shippers and freight forwarders are often yearly agreements. These yearly agreements do not include numbers of containers, but origin-destination pairs that shippers think they will want to transport containers from and to that year, without promises. Usually, the price for transporting a container is settled per kilometre or origin-destination pair and type and size of the container. Within that year, the price is still influenced by the diesel costs that fluctuate a lot. Some trucking companies also want to charge extra costs to shippers for the costs of waiting in the queue at busy terminals, but it depends on the agreements that they have whether the shippers will pay for this, as some do not want to do this.

Next to these long-term agreements between trucking companies, shippers and freight forwarders, these parties also make use of the spot market to arrange the container transport between the terminals and the hinterland. Websites like U-turn provide a market where trucking companies can present their services and shippers and freight forwarders can present their demand for container transport. Because of the current market conditions, where there is a lot of demand for container transport and no oversupply of truck drivers, trucking companies can usually make more money on the spot market than in yearly agreements. However, long-term agreements with shippers and freight forwarders assure more stability and guarantee of container transport over a longer period. Lastly, trucking companies also communicate with each other whenever the demand of their clients is more or less than their transport capacity, so they exchange transport between each other. Of course, they are still competitors, which means they will not always give each other the best possible deal, but those arrangements will often benefit both trucking companies.

4.2.2. Order creation: from shipper to truck driver

Whenever a shipper wants to transport an import container from one of the terminals to their location in the hinterland or an export container from their location to the terminal, he communicates this, including the time the container should arrive at his location, to his freight forwarder or his own trucking companies. The choice of trucking company by the shippers and freight forwarders can be the one that they trust and work with the most, but they can also compare the transport prices between the trucking companies that they have agreements with. The trucking company will check if they still have available truck drivers and if this is the case, accept the order. If they are not available anymore, shippers and freight forwarders have to contact another trucking company. However, whenever a shipper always uses one trucking company for (almost) all their container transport, that trucking company will sometimes be the one that arranges the transport with other trucking companies that do have available truck drivers for that time. Usually, the trucking company receives rough container numbers from the shippers and freight forwarders a week in advance. The actual number of containers to be transported and at what time they should arrive at the location of the shipper/freight forwarder, are often communicated one day in advance, so the trucking companies can create the planning for the next day. As stated above, trucking companies can also receive transport orders from the spot market instead of their usual shippers and freight forwarders. At the spot market, the time between the order and the actual transport is often little.

At the beginning of their work shift, truck drivers receive the route they will have to drive per shipment. For example, receive an import container at terminal A and bring it to location B in the hinterland. However, trucking companies often try to make the trip to the terminals as efficient as possible, because there are waiting times at the terminals. Thus, a truck driver can be sent to deliver a container at a terminal and then, if possible, pick up a container at that terminal and deliver it somewhere in the hinterland. The locations truck drivers have to visit can be distinguished into four categories; terminals, customers (in the hinterland), empty depots (to deliver or pick up an empty container) and a (private) hub if a trucking company would make use of this. After finishing the route that trucking companies sent to them, truck drivers will wait for new instructions.

4.2.3. Trucks visiting terminals and hinterland

When arriving at a terminal gate, trucks first have to pass the security gate to get in. Depending on how busy it is, trucks will have to wait in line to enter the gates. After the gate, they will have to declare who they are and for which container(s) they are visiting the terminal. They will receive the area within the terminal they will have to drive to. Depending on how busy that area is, they can visit it immediately or they will have to wait for the approval to go there. All large container terminals in the port of Rotterdam are open 24 hours per day so that trucks are also able to arrive during the night. Spreading the working load equally over the whole day is positive for their service quality towards arriving truck drivers and leads to their capacity being used more efficiently. At this moment, the working load during the day is at its maximum capacity for terminals, as they need to handle almost all trucks arriving at their terminal. Because at night almost no trucks are arriving every hour, they do not assign a lot of employees to work at night. Some of the container terminals have a slot appointment system, to reduce the number of trucks arriving at the same time. However, truck drivers are often still waiting in front of the terminal until they are allowed to enter the terminal at their slot time because they can not do anything else anymore before that time. Moreover, the time slots are not really leading to more truck drivers driving at night (this can also be found in the literature in section 2.3.1).

Locations in the hinterland where truck drivers need to deliver and pick up a container are often distribution centres of the shipper or freight forwarder. Almost all of these locations are only open during working hours (between 07:00 and 16:00). Thus, in most cases, trucking companies can only send a truck driver to pick up or deliver a container at a location in the hinterland between those hours. Very few locations do allow trucks to deliver a container during the evening and night because they want an employee to be present whenever the truck driver is unloading the container, but they don't want to have employees working outside of working hours, at that results in high costs for them. This is the reason almost all container transport is done during working hours.

4.2.4. Consequences of waiting times at terminals

Because of the opening hours of location in the hinterland that cause trucking companies to transport containers almost only during working hours, long waiting times at terminal gates occur between 05:00 and 16:00. Because of the expanding container transport all over the world, the waiting times at container terminals are increasing. These waiting times lead to several consequences for various actors. The actors that are influenced directly are of course truck drivers that have to wait in front of container terminals before they can enter. Not only do these waiting times lead to a lot of angry and frustrated truck drivers, but truck drivers also often exceed the maximum number of hours they are allowed to work, because of unexpected waiting times on their last trip. But most importantly, truck drivers can transport fewer containers per shift because of the long waiting times.

Because of the waiting times at terminal gates, fewer containers can be transported per day and thus, trucking companies are making less profit. Furthermore, waiting in front of a terminal is very costly for trucking companies, as they have to pay their truck drivers and trucks, even though no transport is being done. Some trucking companies try to let the shipper of the container pay for the (extra) waiting costs at terminals, especially when the waiting time was longer than normal. However, it depends on the shipper if they are willing to pay for these costs. Also, it is often hard to prove the exact time a truck has waited in front of a terminal for a specific container, especially when the truck delivers and picks up a container at the same terminal visit. Moreover, the waiting times lead to uncertainty in the arrival time of trucks at the location in the hinterland and more containers arriving too late. A consequence for trucking companies is that they sometimes have to wait on other containers that are now being unloaded until they can unload their container. Furthermore, if it was their last trip of the day, they are sometimes not even allowed to unload a container at the distribution centre anymore, because employees are already heading home. They will have to return the next day and unload the container and drive to the Maasvlakte before beginning another shipment. Thus, the number of containers they can transport the next day is also influenced.

Of course there are also consequences of the waiting times at terminals for shippers. As stated above, some of the shippers pay trucking companies for extra waiting costs at terminals. However, the main consequences for the locations in the hinterland (like distribution centres of shippers), are uncertain arrival times of containers and containers arriving too late. Sometimes when a container did not arrive on time, employees at that location are obliged to wait until the container has arrived. This leads to extra costs for those companies as they are paying their employees while they are not doing anything. Furthermore, companies that need to do food inspections, like importers of fruits and vegetables, have to make appointments for the inspectors coming to their location to check some containers. In some cases, the container has arrived too late and the appointment with the inspectors has to be rescheduled. This leads to extra costs for the shippers. In some cases, when shippers think the truck driver had to leave earlier than they did, they will try to

make the trucking company pay for the extra costs they made. However, trucking companies are only willing to pay for this when it was their fault (for example if the truck driver has overslept) and not if the waiting times were longer than expected. As stated in the previous section, also terminals benefit from equally spreading the arrival of trucks. Thus, the long waiting times are also disadvantageous for terminals and their service quality towards truck drivers.

Furthermore, interviews with the Port of Rotterdam and with the Ministry of Infrastructure and Water Management concluded that also they would like to see a better distribution of truck transport to and from the port of Rotterdam. Reasons for this are the numerous consequences these peak hours of trucks have for the port, but also the Netherlands. The main consequences of these peak hours at terminals are congestion and waiting times in and around the port of Rotterdam, congestion on important corridors (for example highways in North Brabant), emissions of idling trucks, the attractiveness of the port of Rotterdam and the attractiveness of the industries in the Dutch hinterland of the port. Both the Port of Rotterdam and the Ministry of Infrastructure and Water Management have participated in discussions to find a solution for spreading truck arrivals at terminals. However, both of them would like to see a solution that does not need continuous financial aid to survive. A one-time investment for the implementation of a solution is something the Port of Rotterdam and the Ministry both might agree on if the solution is really promising and in line with their current vision.

4.2.5. Influences of decisions about night-time transport

As stated above, the truck arrival pattern and waiting times at terminal gates have various consequences for multiple actors. To answer the second research question (*What influences each actor's decision that can lead to night-time container transport?*), this section will elaborate on the factors that influence the decisions of actors within the container transport between the seaport and the hinterland that can lead to night-time container distribution to reduce waiting times at terminals. Also, their decisions about using and investing in a hub with extended opening hours are taken into account, as such a hub can influence the choice of transporting containers during the day or night. Based on literature retrieved from the internet and the Port of Rotterdam, graphs were set up with factors that influence the decisions of each actor (trucking companies, shippers, freight forwarders, terminal operators, the Port of Rotterdam and the Ministry of Infrastructure and Water Management). Interviews with these actors have updated and validated these graphs, which can be found in appendix D. These graphs show what are the factors that influence the decisions of all actors about the time schedule (day or night), route schedule (direct or via a hub) and possibly investing in a hub with extended opening hours. It can be seen that trucking companies are the actors actually deciding on the time and route scheduling of a container. However, this choice is influenced by the decisions of shippers (if they will pay for using a hub, if they accept containers at night and if they allow their containers to be transported via a hub). Also, the opening hours of terminals and empty depots influence trucking companies' decisions about the time and route schedule. Furthermore, decisions on investing in a hub with extended opening hours (by any actor) influence the price, safety and opening hours of such a hub. In figure 4.1 all the influences of decisions about night-time transport are given.

As can be seen, the decision of a trucking company (also called carriers) to transport containers directly or via a hub influences their decision to transport at night or during the day. The reason for that is if the shipper (who is also the receiver of the container) is not open at night, the only possible way of visiting the terminal at night and delivering the container somewhere is to make use of a hub with extended opening hours. Whether the trucking company chooses to drive directly or use a hub, influences the number of kilometres driven, the total time the truck driver has spent in front of or inside a terminal or hub (the waiting time) and of course the costs of using a hub. The time of transport (day/night) influences the waiting time (as that is much higher during working hours), the driving speed (as less congestion at night leads to a higher average speed) and the labour costs (as those are higher during the night). The driven kilometres, waiting time and driving speed all influence the number of containers that a trucking company can transport to and from the terminals per day. This amount leads, together with the price per container which is decided in a contract/agreement (based on the origin and destination, the expected costs for that OD-pair and the type of container), to the income for that trucking company. The costs of a trucking company are built up by the transport costs (influenced by the driven kilometres), the labour costs (determined by the hours employees have worked, which is influenced by the waiting time, driving speed and the time schedule), material costs (like renting a chassis) and the costs for the trucking company to use a hub. The height of the latter also depends on whether the shipper contributes to paying for the use of the hub. Other operational decisions that shippers make that are important in this figure are their opening times (whether they accept containers at night) and the restrictions of the route schedule (whether the container is allowed to pass a hub). All these decisions of the shipper are partly influenced by the costs of unloading containers at the receiving location in the hinterland. The reason for this is the extra costs that shippers make when a container arrives later than the requested time because of the waiting times at container terminals. Both trucking companies and shippers, but also other actors,

can make the long-term decision to invest in a hub with extended opening hours, which will of course influence the characteristics of the hub (like the costs, safety and opening hours).

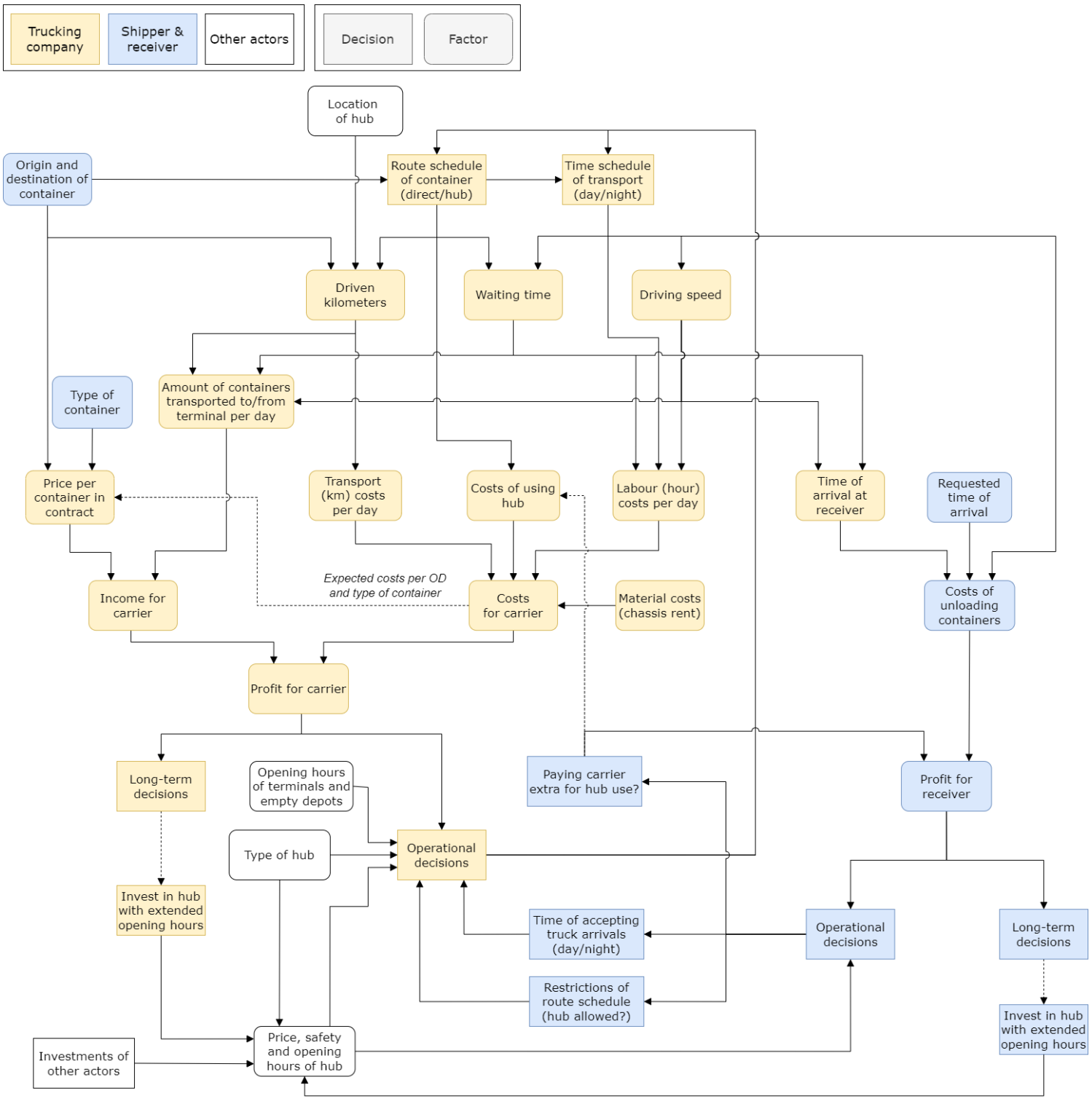


Figure 4.1: Factors that influence decisions about time and route schedule of containers

4.3. Introducing a hub with extended opening hours

The previous section has discussed the container truck transport system between port and hinterland, including the consequences of waiting times at terminals for all actors involved and all the factors that influence each actor's decision that can lead to night-time container transport. This section will elaborate on the introduction of a hub with extended opening hours in this system. As stated before, this hub will facilitate night-time container transport to the container terminals in the port, as receivers in the hinterland usually provide restrictions of arrival times of trucks at their facility, which are often during the daytime. Figure 4.2 gives an example of a hub scenario, to show to which nights the container transport is shifted when a hub is added to the system. The upper sketch describes an import container going from the terminal to the hinterland, the lower sketch describes an export container going the other way. As can be seen, the arrival times in the hinterland are fixed and the transport from and towards the terminals is adapted according to this.

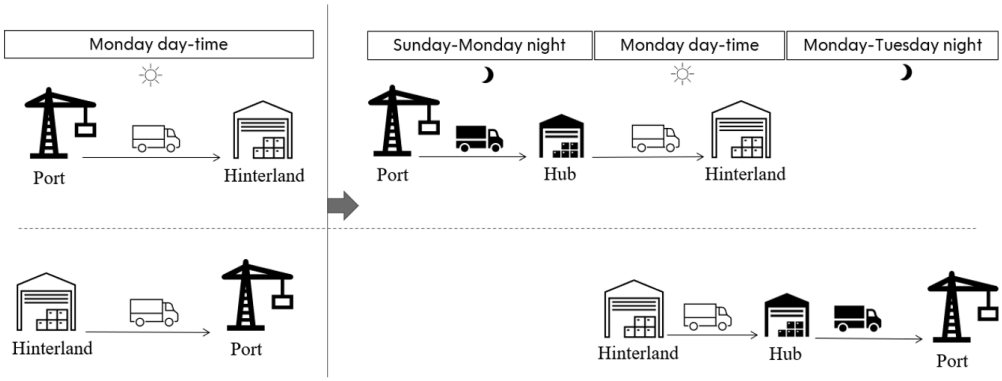


Figure 4.2: Times of day of container transport in a hub scenario

The following sections will discuss the possible gain, challenges and scenarios of adding a hub with extended opening hours. Information about these topics is gathered by the interviews conducted with actors and experts in the field.

4.3.1. Possible gains of a hub with extended opening hours

If after the implementation of a hub with extended opening hours, actors will use the hub and perform night-time transport, this could lead to several possible gains. Not only could waiting times at terminal gates be lowered, but more night-time transport could lead to other possible gains. The possible gain per actor could be the following:

- Trucking company that uses hub: lower waiting times at terminal, more possible containers to be transported per shift and possibly lower total costs per tour (even though drivers are more expensive at night and costs for using the hub are needed, the total costs could be less because of a reduction of (the high) waiting time costs and the lower driving times during the night)
- Trucking company that does not use the hub: lower waiting times at terminals
- Receiver: more reliable transport (lower risk of containers arriving too late)
- Terminal: a better spread of its operations and lower waiting times (better service quality)
- Port of Rotterdam: better accessibility, higher attractiveness
- Social gain: less congestion and emissions of idling trucks (some experts state the social gain is €10 per rush-hour avoidance of a freight truck, thus the social gain per year could quickly be quite high)

4.3.2. Challenges of a hub with extended opening hours

As stated in the previous section, a hub with extended opening hours can lead to possible gains for almost every actor involved. However, there are also some challenges implementing a hub with extended opening hours in this container transport system. A challenge that could arise is that the problem of waiting times at terminals is a problem for multiple actors, as stated in section 4.2.4. Thus, reducing the waiting times with the use of a hub with extended opening hours has gains for various actors. This is a positive aspect, but could also lead to a challenge when deciding who should pay for the use of a hub and who should profit from lower waiting costs at terminals. Another aspect of the system that contributes to this challenge is that there are actors involved in the same processes, but do not have a financial relationship between them, like trucking companies and terminals. However, some experts have stated that it is a possibility that terminals will ask for money from trucking companies that want to visit the terminal during peak hours (PortOfRotterdam, 2021a).

This could in the future lead to a higher need for night-time container transport.

Another challenge of implementing a hub with extended opening hours is the fact that extra costs are added to the process, as the use of a hub will cost money, especially when the container has to be removed from the chassis. Furthermore, because the transport is split into two legs and the hub might not be exactly on the route between the terminal and customer, the number of kilometres trucks will have to transport the container might increase. However, the transportation costs of night-time transport are probably lower than the transportation costs of daytime transport, as even though the truck driver's salary is higher at night, the empty roads assure much faster transport at night. Some carriers have stated that they could transport almost double the number of container trips during the night, compared to during the day(PortOfRotterdam, 2021a). Furthermore, since the roads are empty at night, the container transport between the terminals and the hub might be done by long trucks that can carry several containers. This will lead to lower transport costs for this leg of the container transport. Further challenges of introducing a hub with extended opening hours are reviewed in section 7.1.1 of the discussion.

4.3.3. Scenarios of adding a hub with extended opening hours

In the section 4.2.5, the factors that influence decisions on night-time container transport are being discussed. Next to the possibility of receivers of containers being open at night, a possible solution for facilitating night-time container transport is using a hub with extended opening hours. Of course, the type of hub and its characteristics influences whether a trucking company decides to use it. All possible variations of hubs to facilitate night-time container transport are investigated. Below, a list is given with all the critical variables of a hub with extended opening hours.

1. Type of hub
2. Total costs per truck
3. Turnaround time at hub
4. Capacity
5. Location
6. The users (private/public)
7. Opening hours

With the use of the interviews (appendix G) and opinions of experts at the Port of Rotterdam, the most logical and presumable hub characteristics are chosen to include in the simulation model. The types of hubs that are taken into account in this research are on the one hand a chassis-exchange and on the other a container hub. At a chassis-exchange, containers are stored with the chassis it is standing on. The truck driver parks its chassis at a parking space and picks up another chassis with a container on it. Figure 4.3 shows a chassis-exchange in the port of Long Beach in California.

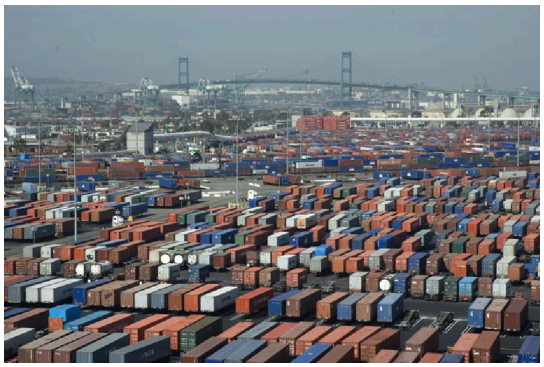


Figure 4.3: A chassis-exchange in the port of Long Beach (Dekker et al., 2013)

Interviews with trucking companies have discovered that trucking companies do not like to share their chassis with other companies. However, it is possible to share chassis with over drivers within the same company. Extra chassis have to be bought to be stored at the chassis-exchange. However, not for every container a new chassis has be acquired, as trucks that are using the hub can leave their chassis at the hub to be used during the night. An online research about container chassis that are on sale in the Netherlands (Trucks.nl, 2022) concludes that the price of a chassis is often in between €2.000 and €8.000, with a mode of €4.000. These costs increase the capital expenses of a chassis-exchange.

At a container hub, the containers are removed from the chassis and stacked on top of each other while being stored. Figure 4.4 shows a reach stacker stacking containers on top of each other, as it would be done at a container hub.

Figure 4.4: A reach stacker stacking containers (Hyster, 2022)

The main advantage of a container hub over a chassis-exchange hub is that up to 5 containers can be stacked, thus less space is need to store the same amount of containers. However, this means a few reach stackers with operators are needed, which increase the to capital expenses. An online research about reach stackers on sale (LiftsToday.com, 2022; Alibaba.com, 2022) concludes that the price of a reach stacker is often in between €100.000 and €300.000. Furthermore, it leads to higher operational costs, as a container needs to be handled by a reach stacker twice and the turnaround time at a container hub is higher than at a chassis-exchange, as taking a container of a chassis takes time. Experts at the Port of Rotterdam have stated that realistic turnaround times at a chassis-exchange and a container hub are 10 and 20 minutes, respectively. As further explained in section 5.4.2, the costs for waiting and (un)loading are €38,32 during the day and €46,21 during the night (ComitéNationalRoutier, 2019; van der Meulen et al., 2020). As each truck moving from a direct route to a route via the hub leads to two hub visits (to deliver and pick up the container(s) at the hub), the turnaround times multiplied by the daily (un)loading costs should be added up to the turnaround times multiplied by the nightly (un)loading costs. This leads to costs of around €14 for the time it takes to visit a chassis-exchange twice and around €28 for the time it takes to visit a container hub twice. Furthermore, ground costs and maintenance costs for the hub property (e.g., cameras and a fence) should be taken into account for the total hub costs per truck. If the hub is located in the port area, which is the case with both the Maasvlakte and the Botlek area, the ground costs of a hub depend on the amount the Port of Rotterdam asks for using its ground. If the Port of Rotterdam would build the hub, different costs might occur than if other actors would build the hub. Thus, the estimated total costs per truck for trucking companies for using a chassis-exchange would be between €15,00 and €20,00. At a container hub, the added costs are higher as the operators of the reach stackers have to be paid. Thus, the total costs per truck are estimated to be between €30,00 and €50,00. Sensitivity analyses are executed in chapter 6 to analyse the different results when varying the total costs per truck. Table 4.1 shows all scenarios taken into account in the simulation modelling.

Table 4.1: Scenarios of adding a hub with extended opening hours to the model

Scenario	Type of hub	Turnaround time (minutes)	Total costs per truck (euros)	Capacity (# of trucks)	Location
1	Chassis-exchange	10	€15 - €20	100	Maasvlakte
2	Chassis-exchange	10	€15 - €20	100	Botlek
3	Chassis-exchange	10	€15 - €20	200	Maasvlakte
4	Chassis-exchange	10	€15 - €20	200	Botlek
5	Container hub	20	€30 - €50	300	Maasvlakte
6	Container hub	20	€30 - €50	300	Botlek

The capacity of a hub with extended opening hours should be large enough to make a difference in waiting times, but not too large so that waiting times will emerge at the hub and terminal gates during the night. As can be seen in table 4.1, the capacity of the chassis-exchange will be varied between 100 and 200 trucks per 24 hours. As a container hub can store more containers, a capacity of 300 trucks will be analysed in the simulation model (which is based on numbers of trucks). An interview with a terminal stated that, because of combined trips, the average number of containers being brought and picked up during the terminal visit of 1 truck is 1,32 (G.3). Since hub visits can also be combined, scenarios

where 100 and 200 trucks that visit the terminal will use the hub, correspond with a hub capacity of around respectively 132 and 264 containers. In the container hub scenarios, the capacity of 300 trucks corresponds to around 395 containers per 24 hours. Section 6.5.1 elaborates further on the parking and storage places needed for these hubs. The location of a hub with extended opening hours matters a lot for the number of trucks that would want to use the hub. The Port of Rotterdam has stated that they are interested to analyse both a hub close to the terminals, on the Maasvlakte, and a hub close to industrial sites, like the Botlek area. The Botlek area is chosen as the industrial site, as it is one of the zones with the most demand for trucks coming from the container terminals. Moreover, the zones around the Botlek area also have a lot of demand for trucks coming from the terminals. Whether the hub would be private or public, depends on whoever will create the hub. When several trucking companies would invest in a hub with extended opening hours, this hub will probably be private so that only they can use it. If the Port of Rotterdam would invest in a hub with extended opening hours, the hub will probably be public for everyone who wants to use it. Because no data and information are known about which container belongs to which trucking company, the model assumes the hub is public. The opening hours of the hub are set to be 24 hours per day, as trucking companies would want to make as many tours as possible if they would choose to let their truck drivers drive at night.

5

Modelling and simulation of container transport and waiting times

In chapter 5 the modelling of waiting times at container terminals in the port of Rotterdam is discussed. All aspects of the modelling framework (figure 3.3) given in chapter 3 are taken into account. First of all, the data preparation, analysis and verification of the trip generation are discussed. Secondly, the terminal model is explained, calibrated, verified and validated. After this, the data preparation, analysis and verification are mentioned. Furthermore, this chapter includes the route assignment of trucking companies, which is a discrete choice model. Moreover, the agent interaction model is discussed. First, a conceptual agent-based model is analysed. Secondly, this section describes how the agents are modelled in the simulation model. Lastly, a list of all assumptions made during the container transport simulation is given.

5.1. Trip generation

5.1.1. Data preparation

Data collection

The first data that is needed to forecast transport data in a model, so that eventually the waiting times can be analysed, is the number of trucks arriving and departing at the terminals on the Maasvlakte. These numbers are predicted by the use of trip generation. Four of the five large container terminals on the Maasvlakte have traffic counting points installed in front of the gates that count all traffic passing the counting point per quarter of an hour. These four containers are taken into account in the simulation model. The counting points distinguish between incoming and outgoing traffic. Furthermore, the traffic is categorized in passenger cars (with a width smaller than 5.6 meters), light freight traffic (width between 5.6 and 12.2 meters), medium freight traffic (width between 12.2 and 19.5 meters) and heavy freight traffic (width higher than 19.5 meters). Since the site where this data can be found is still in development, the only week where the data is correct and complete for all terminals is from the 11th of January 2021 to the 17th of January 2021. Thus, data from this week is used in the model. The source of this data is the National Road Traffic Data Portal. Figure 5.1 shows the number of freight trucks arriving at a certain terminal per hour for every day of that week.

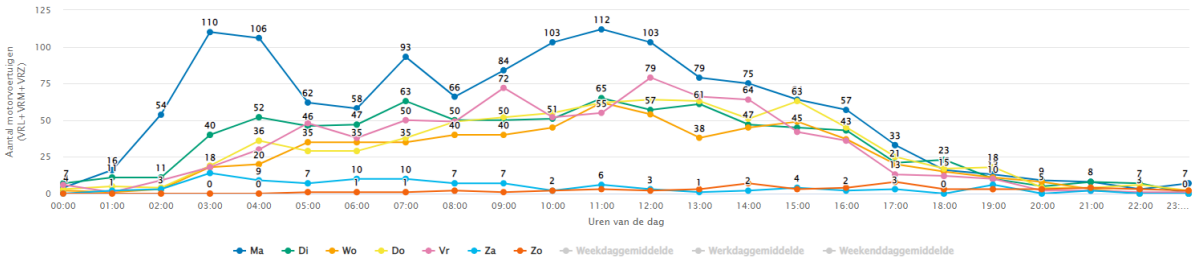


Figure 5.1: Number of freight trucks per hour going to a terminal (Port of Rotterdam, 2021)

Data cleansing

As a 20ft container is 6.1 meters (20 feet) long, the freight traffic categories are sufficient for all container transport. The passenger cars are not included in the trip generation data. For all four container terminals, the numbers of arriving and departing trucks per hour of the day are taken into account for an average working day. Saturday and Sunday are not considered in the simulation, as almost no trucks are visiting the terminals during the weekend.

5.1.2. Data analysis

The observed data of trucks arriving and departing at every hour of the day for every terminal is given in figure 5.2. These are the observed arrival and departure profiles on an average working day in the second full week of January 2021. On average, as can be seen in this figure, more trucks visits terminals C en D than terminals A and B. Furthermore, terminals C en D have high peaks of arriving trucks, compared to terminals A and B. If the terminal counting point data will include more data in the future, the arrival patterns should be updated to get arrival and departure patterns that match the average working day in a whole year.

Figure 5.2: Observed arriving and departing profiles on an average working day

Since no other data is known for the time of day choice of trucking companies, the arrival patterns shown in figure 5.2 are the input for the simulation model. Since one working day is modelled, the average total number of trucks visiting each terminal are sent as orders by customers to trucking companies 24 hours in advance. For terminals A, B, C and D, these amounts are respectively 854, 1388, 1840 and 1590. The observed arrival patterns per terminal are given to the model as a distribution. Then, trucking companies draw a time of the day for each order from these distributions. If data on trucking companies' time of day choice would be available, future research can be done on a time of day choice model. This is discussed more thoroughly in chapter 7.

5.1.3. Verification

For verification of the trip generation, the number of trucks arriving at each terminal is analysed after each simulation run. This number always corresponds with the number of trucks that should visit each terminal, stated in section 5.1.2. Furthermore, the number of trucks arriving per hour of the day should be verified. These values vary each simulation run, as the time of day trucks arrive at the terminal is drawn from a distribution. However, the simulated number of trucks per hour should not be too different from the observed ones. Thus, the truck arrivals are verified using visual verification, statistical analysis and analysing the correlation between the observed and simulated arrival patterns.

Visual verification

For every terminal, the observed and simulated truck arrival profiles are shown in figure 5.3. By visual verification, it can be seen that for all terminals, the simulated arrival patterns follow a comparable trend as the observed arrival patterns. To quantify the comparison between the simulated and observed arrivals, a statistical analysis is executed and the correlation of the two data sets is tested.

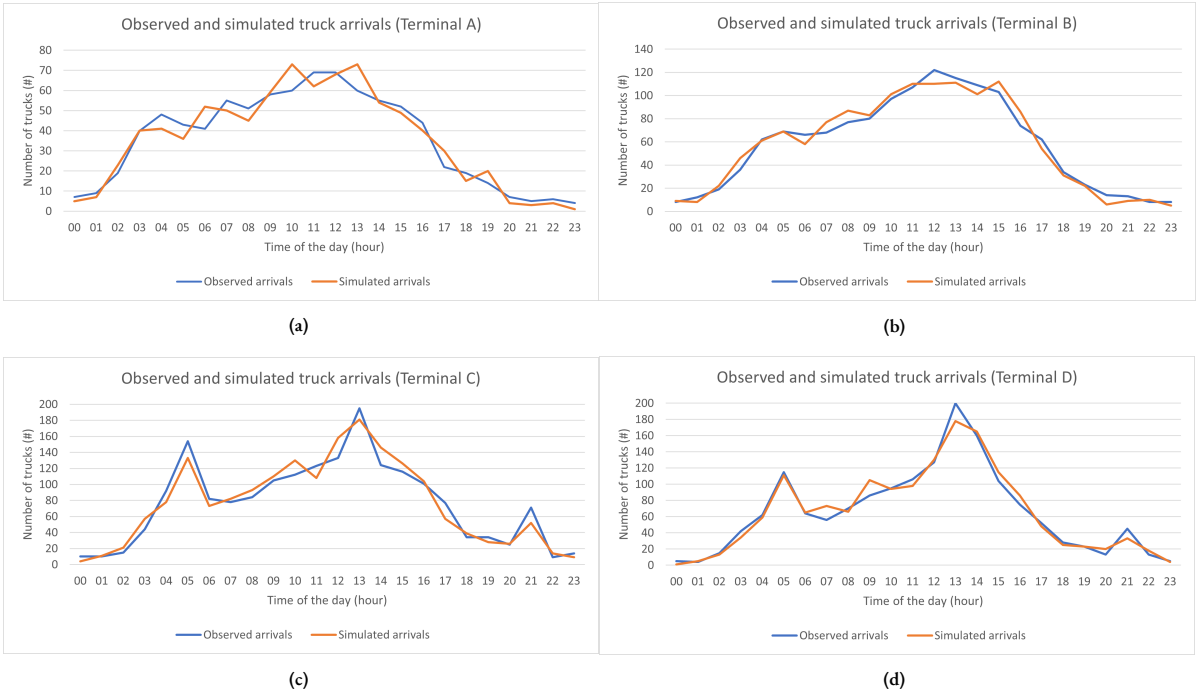


Figure 5.3: Visual verification of truck arrivals

Statistical analysis

For every terminal, a statistical analysis is executed to compare the means of both data sets. This is done using an independent two-sided t-test for the observed and simulated arrivals. The t-value (t) of this t-test is calculated using the means of both data sets ($\overline{x}_i$), the pooled standard error (s^2) and the number of observations in each data set (n_i), as can be seen in the following equation.

$$t = \frac{\overline{x}_1 - \overline{x}_2}{\sqrt{(s^2 * (\frac{1}{n_1} + \frac{1}{n_2}))}} \tag{5.1}$$

The null hypothesis (H0) states that the observed and simulated arrival patterns are similar. The alternative hypothesis (H1) states that the observed and simulated arrival patterns are different. The null hypothesis is accepted if the t-value is higher than -1.96 and lower than 1.96 and if the p-value is higher than 0.05. From table 5.1, it can be observed that for all terminals, the null hypothesis is accepted and thus, the observed and simulated arrival patterns are similar.

Table 5.1: Independent t-test of truck arrivals for every terminal

Terminal	t-value	p-value
Terminal A	0.019	0.985
Terminal B	-0.007	0.994
Terminal C	0.006	0.996
Terminal D	-0.011	0.991

Correlation truck arrivals

For every terminal, the correlation is tested to evaluate the goodness of fit. This is done by calculating the R-squared with the observed and simulated truck arrivals. R-squared (R^2) is calculated using the sum squared regression, which compares the simulated arrivals ($\hat{y}_i$), the observed arrivals (y_i) and the mean of the arrivals ($\overline{y}$). This can be seen in the following equation (Barrett, 2000).

$$R^2 = 1 - \frac{\sum_i (y_i - \hat{y}_i)^2}{\sum_i (y_i - \overline{y})^2} \tag{5.2}$$

The R-squared can be found in table 5.2 for every terminal. Furthermore, the correlation between the observed and simulated truck arrivals is evaluated by analysing both data points for every hour of the day in figure 5.4. An R-squared

value close to 1 signifies a strong positive relationship between the compared data sets. Since the maximum deviation is 0.065, it can be stated that the relationship between the simulated and observed arrivals is rather strong.

Table 5.2: R-squared of truck arrivals for every terminal

Terminal	R-squared
Terminal A	0.935
Terminal B	0.972
Terminal C	0.938
Terminal D	0.970

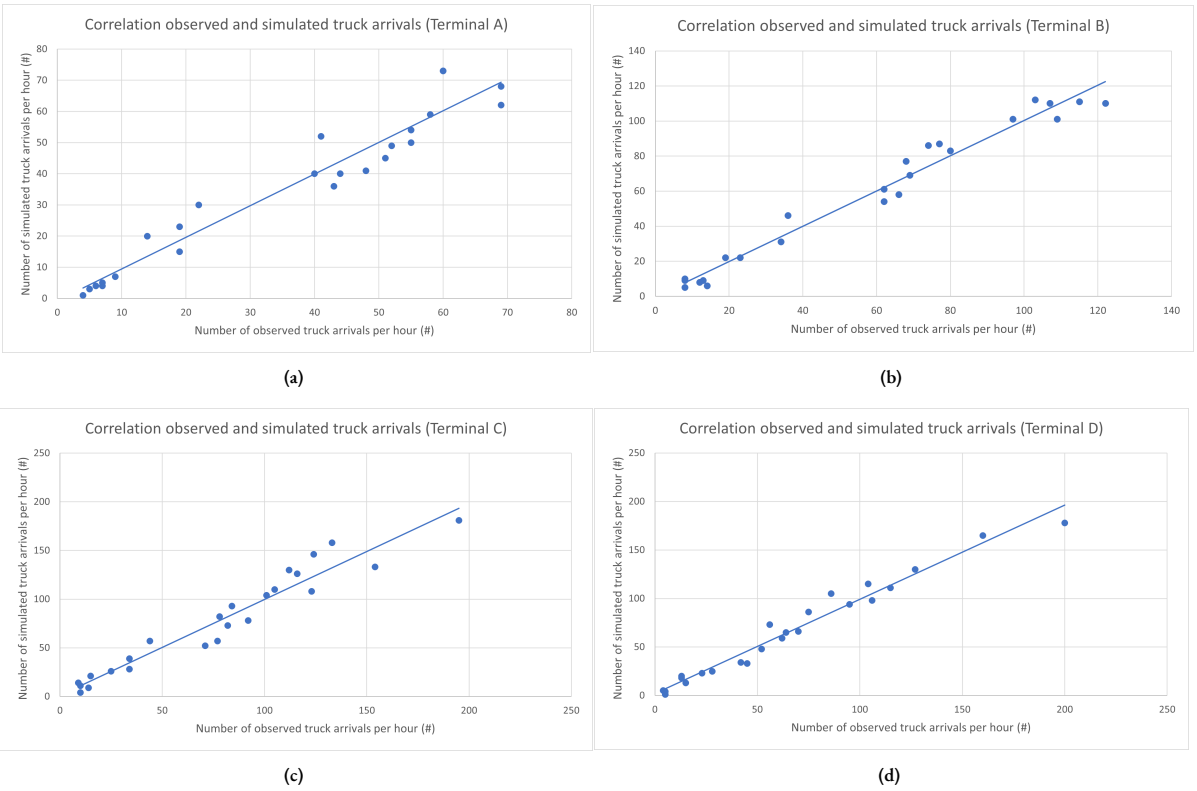


Figure 5.4: Correlation of observed and simulated arrivals

5.2. Terminal model

A terminal is a multi-server queueing model (M/M/c) where trucks are being served by several cranes, that are the multiple gates. The input of the queueing model is the arriving trucks at the terminals. If no gate is available to serve the truck at the moment of arrival, the truck will have to wait in the queue. The discipline of this queue is first in, first out (FIFO). The output of the model is the departing trucks, after being served. The time in the system for trucks, including the waiting time in the queue, is calculated based on the arriving trucks, the number of gates and the service time. Most frequently, the service times of the terminal models are exponentially distributed (Kendall, 1953).

5.2.1. Calibration

Since the actual number of gates and service time is unknown for the container terminals on the Maasvlakte, these parameters are calibrated so that the outcome of the terminal model, which is the departure pattern, is closest to the observed pattern. Since the service time is distributed exponentially, a minimum service time and lambda for the distribution should be calibrated for the terminals. Optimization experiments are run for every terminal to find the number of gates, minimum service time and lambda of the service time distribution so that the difference between the simulated and observed departure patterns are minimized. This is done using the mean square error between the observed and simulated

departures. The mean square error is calculated by dividing the sum of the squared differences between the observed (Y_i) and simulated ($\hat{Y}_i$) departures by the number of observations (n).

$$MSE = \frac{1}{n} * \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2 \tag{5.3}$$

Several optimization experiments are run to optimize the number of gates, minimum service time and lambda of service time distribution, by minimizing the mean square error between the observed and simulated departures for every terminal. Table 5.3 gives the optimal parameters for every terminal and the corresponding minimal mean square error (MSE) found.

Table 5.3: The optimal parameters of the terminal model after calibration

Terminal	Number of gates (#)	Minimum service time (minutes)	Lambda of service time distribution	MSE	MAPE
Terminal A	19	17.828	1.494	91.833	9.72 %
Terminal B	35	19.609	1.840	87.194	1.39 %
Terminal C	42	19.261	1.721	249.764	11.11 %
Terminal D	37	18.358	2.039	156.944	9.72 %

As can be seen in table 5.3, also the mean absolute percentage error (MAPE) is calculated in the optimization experiments and given per terminal. This is done because every terminal has different magnitudes of numbers of departures per hour. This value is calculated by dividing the difference between the observed (Y_i) and simulated ($\hat{Y}_i$) departures by the observed departures and again, dividing this by the number of observations (n).

$$MAPE = \frac{1}{n} * \sum_{i=1}^{n} \left| \frac{Y_i - \hat{Y}_i}{Y_i} \right| \tag{5.4}$$

Figure 5.5 shows the simulated arrival and departure profiles using the parameters given in table 5.3 for every terminal.

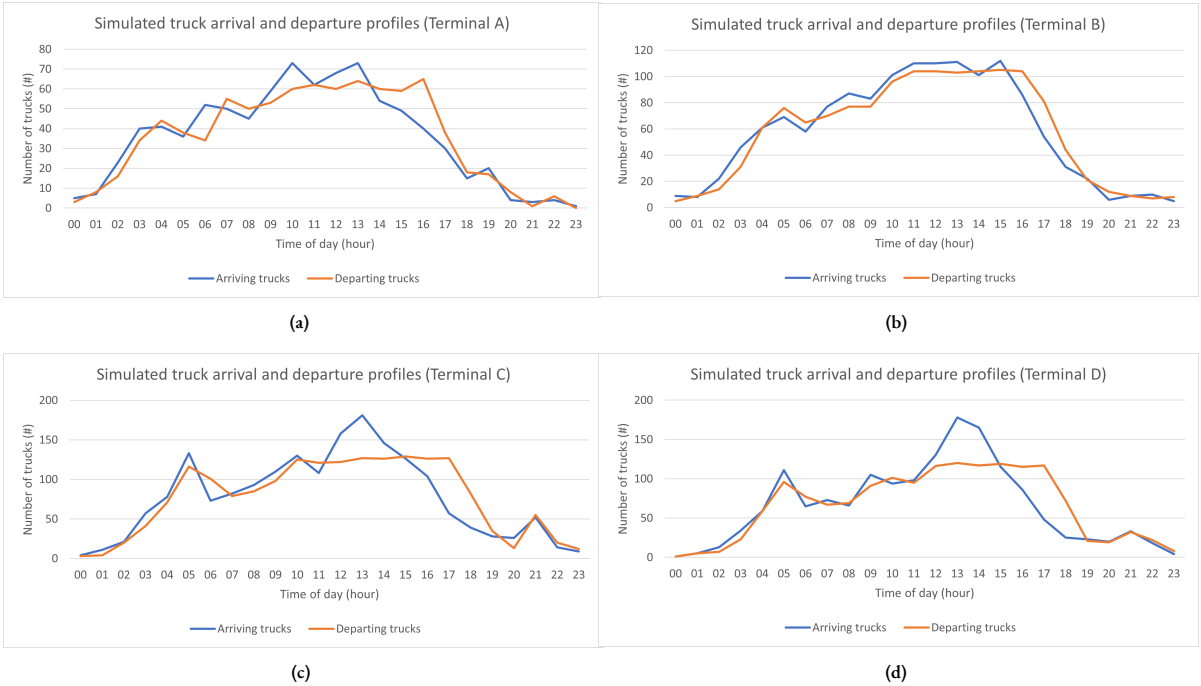


Figure 5.5: Simulated arriving and departing profiles

As can be seen in table 5.3, the minimum service times for all terminals are between 17 and 20 minutes, which are realistic values. The number of gates differs a lot for every terminal, which is logical as some terminals are visited by

much more trucks than others. A small value of the mean absolute percentage error signifies that the simulated and observed departure patterns are similar. The mean absolute percentage errors are rather small, but not zero. Thus, various validation methods are used in section 5.2.3 to compare the simulated and observed arrival patterns. First, section 5.2.2 discusses the verification of the terminal model.

5.2.2. Verification

To verify the terminal model, several aspects of the model are checked. First of all, the flow conserve should be zero. This indicates that the number of trucks that have entered the queueing model of a terminal should have left it at the end of the simulation run. The model simulates all trucks visiting the terminals on an average working day of 24 hours. To ensure that all trucks have left the terminals and are finished with their actions, a cool-down period is added to the model. In this cool-down period, all trucks that were not finished with their actions, finish and only after no activity is observed, the simulation model stops. Furthermore, the trucks are observed during the simulation run to closely watch all steps that are happening in the model. When a truck arrives at the terminal, it enters the queueing model and if all gates are full, waits in the queue. After being served, it leaves the terminal again. All steps of the terminal model are closely checked and they are all working correctly.

For verification of the service process of terminals, the simulated service times are analysed. The service times are averaged per hour of the day and shown in figure 5.6. These numbers are averaged over all simulated service times of ten seeds, to avoid simulation bias. The service time for each truck at every terminal is exponentially distributed with a minimum service time and a rate parameter (lambda) that can be found in table 5.3. It can be seen that the service times act as expected.

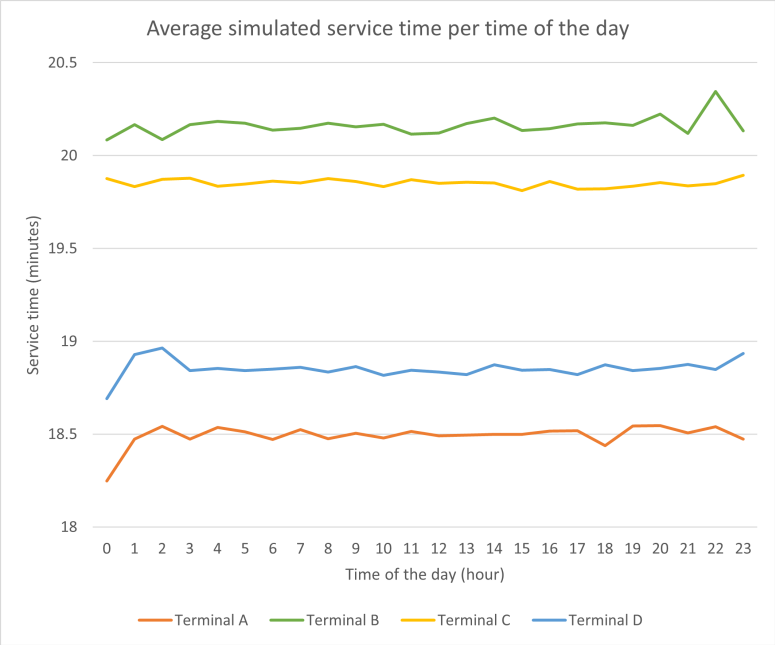


Figure 5.6: Averaged simulated service time per hour of the day for every terminal

5.2.3. Validation

For validation of the terminal model, the simulated and observed departure profiles are compared. This is done by visual validation, statistical analysis and lastly by analysing the correlation between the two data sets.

Visual validation

For every terminal, the observed and simulated truck departure profiles are shown in figure 5.7. By visual validation, it can be seen that for all terminals, the simulated departure patterns follow a comparable trend as the observed departure patterns. To quantify the comparison between the simulated and observed departures, a statistical analysis is executed and the correlation of the two data sets is tested.

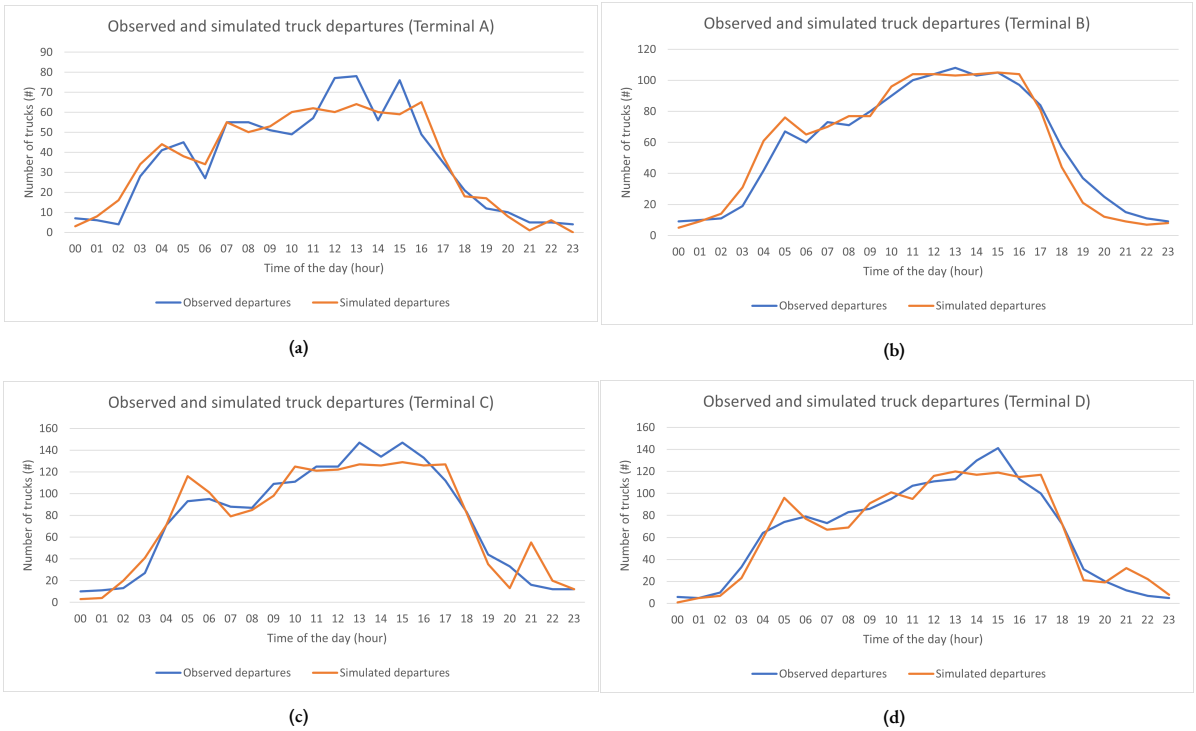


Figure 5.7: Validation of truck departures

Statistical analysis

For every terminal, a statistical analysis is executed to compare the means of both data sets. This is done using an independent two-sided t-test for the observed and simulated departures. The t-value (t) of this t-test is calculated with the formula explained in section 5.1.3. The null hypothesis (H0) states that the observed and simulated departure patterns are similar. The alternative hypothesis (H1) states that the observed and simulated departure patterns are different. The null hypothesis is accepted if the t-value is higher than -1.96 and lower than 1.96 and if the p-value is higher than 0.05. From table 5.4, it can be observed that for all terminals, the t-value is 0.000 or has a deviation of 0.003 and the p-value is 1.000 or has a deviation of 0.003. Thus, the null hypothesis is accepted for every terminal and thus, the observed and simulated departure patterns are similar.

Table 5.4: Independent t-test of truck departures for every terminal

Terminal	t-value	p-value
Terminal A	0.000	1.000
Terminal B	0.000	1.000
Terminal C	0.000	1.000
Terminal D	-0.003	0.997

Correlation truck departures

For every terminal, the correlation is tested to evaluate the goodness of fit. This is done by calculating the R-squared with the observed and simulated truck departures. R-squared is calculated with the formula explained in section 5.1.3. The R-squared can be found in table 5.5 for every terminal. Furthermore, the correlation between the observed and simulated truck departures is evaluated by analysing both data points for every hour of the day in figure 5.8. An R-squared value close to 1 signifies a strong positive relationship between the compared data sets. Since the maximum deviation is 0.11, it can be stated that the relationship between the simulated and observed departures is quite good.

Table 5.5: R-squared of truck departures for every terminal

Terminal	R-squared
Terminal A	0.890
Terminal B	0.959
Terminal C	0.920
Terminal D	0.938

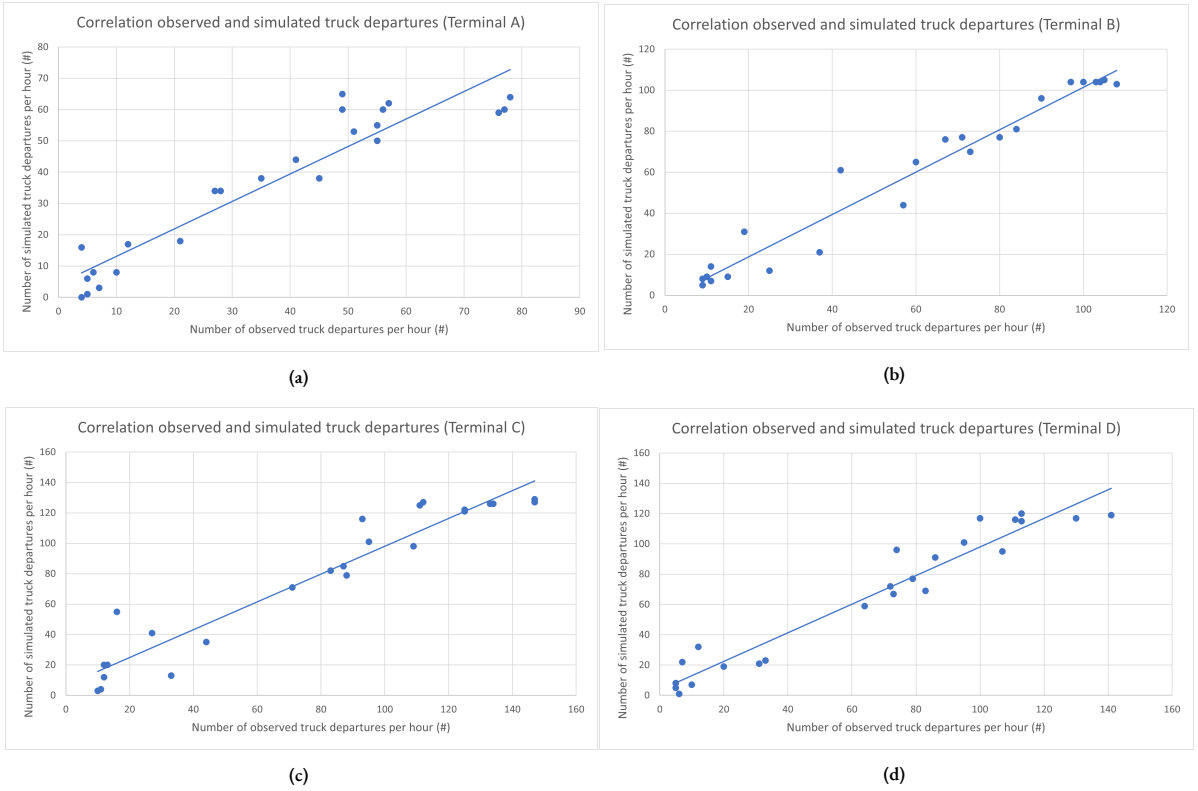


Figure 5.8: Correlation of observed and simulated departures

5.3. Trip distribution

5.3.1. Data preparation

Data collection

The second step in forecasting container transport is trip distribution. To know where the transport is coming from and going to, origin and destination data is needed. The Port of Rotterdam has received the amount of traffic going to and coming from each of the 196 zones in the Rotterdam area, which can be seen in figure 5.9, from TomTom for the last few years. The data also includes traffic arriving from and leaving to locations outside this area, by adding a zone for the (high)ways leaving this area. All traffic driving in and out of the area using these roads are assigned to their leaving/arriving zone. For every container terminal, a zone is created. Thus, the origins of trucks travelling towards the terminals and all destinations from trucks travelling from the terminals can be derived from the data. However, the data does not distinguish between passenger cars and freight trucks and the TomTom data is estimated to be around 17% of all traffic at that moment (TomTom, 2021). Thus, the TomTom data can be used, after data cleansing, for the percentage of trucks going to and coming from certain zones.

Data cleansing

As the TomTom data includes internal zone activity (transportation within the same zone), which is not a part of this research, this data is removed from the data set for all zones. Furthermore, since the TomTom data does not distinguish between passenger cars and freight traffic and passenger probably have different origin and destination zones than freight traffic, the data needs to be cleansed to be more representative for freight traffic. Passenger cars mainly enter terminal

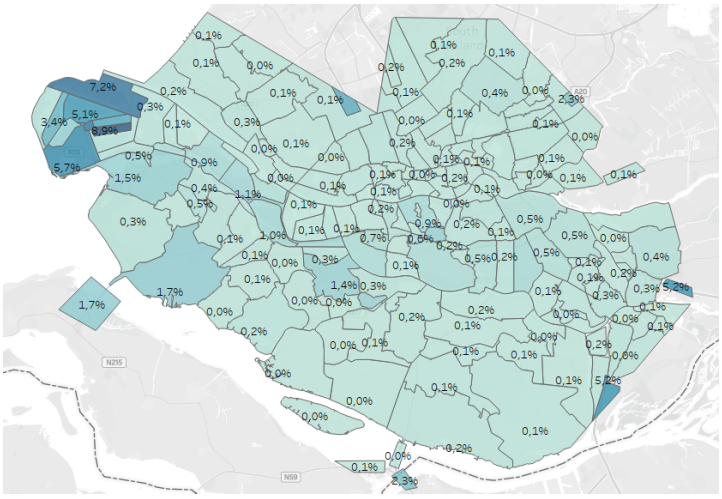


Figure 5.9: All zones in the TomTom data (PortOfRotterdam, 2021c)

zones during hours of shift changes. The data from the counting points in front of the terminals are used to observe the times of day when there are peaks of arriving and leaving passenger cars. In figure 5.10 the average number of passenger cars that are going towards a terminal on the Maasvlakte on weekdays and weekend days are shown per quarter, for the second full week in January 2021 (with complete data). The peaks of arriving passenger cars are very visible in the figure.

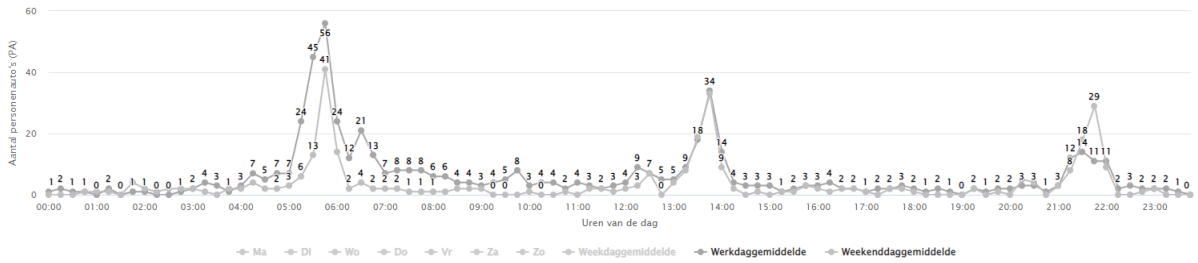


Figure 5.10: Number of passenger cars per quarter of an hour going to a terminal (Port of Rotterdam, 2021)

The data of the traffic counting points in front of all four terminals is used to detect the precise peak hours of passenger cars, both arriving at and leaving from terminals. The peak hours that were found are from 05:00 to 06:30, from 13:00 to 15:00 and from 21:00 to 22:30. These hours are excluded from the origin-destination data from TomTom, as those influence the origins and destinations of freight too much.

Furthermore, to be able to find the travel times of all origin-destination pairs in the simulation for all times of the day with a Google API (which is further discussed in section 5.4.2), not all 196 zones can be taken into account. Only the zones where more than 1% (when leaving out the high values of Maasvlakte and highways at the border of the area) of all containers departing from the container terminals is going are considered, which are 42 zones.

5.3.2. Data analysis and verification

After data cleansing, the percentages of truck transport coming from and going to all zones are averaged over the whole year 2021. This is done for every terminal. Table E.1 in appendix E shows the average number of trucks that drive from and to each zone per terminal per day, where the percentages and the total number of trucks visiting a terminal per day are used. Verification of this data is done by checking with experts at the Port of Rotterdam, whether these values are expected. It can be seen that the largest number of trucks is travelling between region 1 and the terminals. This zone is located on the Maasvlakte. The reason for the large demand for trucks is that a lot of distribution centres are located in this area. The following zones with high amounts of truck traffic to and from the terminals are mainly highways at the border of the Rotterdam area. Also, this is logical, as not all containers stay within the Rotterdam area. Furthermore, no unexpected values are found in the data.

5.4. Route assignment

In the route assignment component of the model, trucking companies decide whether to drive directly between the container terminal and the customer in the hinterland, like the current situation, or to make use of a hub with extended opening hours. A simplified illustration of the alternatives for the route assignment of trucking companies is given in figure 5.11.

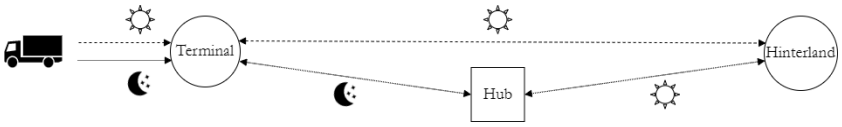


Figure 5.11: Simplified illustration of alternatives for the route assignment of trucking companies

Factors that are taken into account in the choice of trucking companies are hub characteristics, waiting times at terminals, driving costs and time between all zones involved at all times of the day and lastly, how agents interact with each other (for example if receivers would pay the use of a hub or not). When modelling the decisions of people, discrete choice models are used. Section 5.4.1 describes the choice model of trucking companies. After that, the data preparation, data analysis and verification of all factors involved in the choice model are discussed.

5.4.1. Discrete choice model

As discussed in section 3.3, the logit model is used for the choice model of trucking companies that have to decide to use a hub or not. The probability of them choosing to use a hub (P_{hub}), is given in equation 5.5. This probability depends on the observed utilities of the *direct route* alternative (V_{direct}) and the *hub route* alternative (V_{hub}).

$$P_{hub} = \frac{e^{V_{hub}}}{e^{V_{hub}} + e^{V_{direct}}} \tag{5.5}$$

According to the interviews with trucking companies (appendix G), the most important attributes that play a role in the decision of trucking companies are the costs of transport and the time it takes to transport a container. The latter is important because if the time it takes to transport a container reduces, the trucking company might be able to transport more containers per week. Other attributes that could play a role in their decisions (e.g., the type of security of the hub and what truck drivers think of using a hub) are not taken into account in the choice model, as no data on these attributes are available for this research. Moreover, the influences of other attributes would probably be rather small, as trucking companies state that they make almost all decisions based on the costs and time of container transport. Thus, equations 5.6 and 5.7 give the observed utilities of both alternatives.

$$V_{direct} = \beta_{costs} * costs_{direct} + \beta_{time} * time_{direct} \tag{5.6}$$

$$V_{hub} = ASC_{hub} + \beta_{costs} * costs_{hub} + \beta_{time} * time_{hub} \tag{5.7}$$

The preference parameters for costs (β_{costs}) and time (β_{time}) are derived from a research on perceived value of time for truck operators and are respectively -1.638 and -0.524 (Kawamura, 2000). However, the β_{costs} is calculated for US dollars. When converted to euros, this value becomes -1.855. The alternative specific constant for the hub alternative (ASC_{hub}) is unknown as no research has been done on a choice model for truck operators to use a hub or not. Nonetheless, it can be stated that this value should be negative, as truck operators will choose the *direct route* alternative if the utility of both routes (based on the costs and time) is the same, because it is a simpler option. However, when the utility for the *hub route* alternative is larger, they will want to use this route. Thus, the value of ASC_{hub} should not be too large. The value that is used in the simulations is -1. Future research on a choice model on this subject could find better fitting values for the betas and ASC in this case. Equation 5.9 and 5.8 give the formulations of the time per trip ($time$) and total costs ($costs$) for a trucking company. Below them, all variables of the formulas are clarified.

$$time = \sum_{i \in I} \sum_{j \in J} \sum_{t \in T} (td_{ij}^t * x_{ij}^t) + \sum_{i \in I} \sum_{t \in T} (tw_i^t * y_i^t + ts_i * y_i^t) \tag{5.8}$$

$$costs = \sum_{i \in I} \sum_{j \in J} \sum_{t \in T} (cd_{ij}^t * x_{ij}^t) + \sum_{i \in I} \sum_{t \in T} (cw_i^t * y_i^t + ch_i * y_i^t) - rp \tag{5.9}$$

x_{ij}^t = 1 if trucking company drives from zone i to zone j at time of day t within this trip
y_i^t = 1 if trucking company visits zone i at time of day t within this trip
td_{ij}^t = time it takes for driving from zone i to zone j at time of day t
tw_i^t = waiting time at zone i at time of day t
ts_i = service time at zone i
cd_{ij}^t = all costs involved when driving from zone i to zone j at time of day t
cw_i^t = costs of waiting at zone i at time of day t
ch_i = costs of visiting node i (positive if zone i is a hub)
rp = extra amount receivers pay carriers for using a hub (to reduce the chance of a container arriving too late)

5.4.2. Data collection

To determine the travel times at every time of day (td_{ij}^t) between the terminal zones, the customer zones and possible hub zones, the Distance Matrix API from Google Maps is used. This includes the option to collect the travel times between zones at all times of the day, for someday in the future. Because the counting point data that is used was measured in January 2021, a working day in January 2023 is chosen during the collection of travel time data. For the waiting times at terminals at every time of the day (tw_i^t), the base case is used to run the simulation model. The outcome for the model, which is the current waiting times at every hour of the day for all four terminals, is used for the calculation of the time per trip for trucking companies. The base case results can be found in section 6.1. The service time (ts_i) at terminals can be found with the terminal model and are given in figure 5.6 in section 5.2.2. For a hub, no waiting times are assumed and the service time is set to 10 minutes for a chassis-exchange and 20 minutes for a container hub, as explained in section 4.3.3.

With the travel times between all zones at every time of the day, the travel costs (cd_{ij}^t) can be found. If all costs of trucking companies are taken into account, including fixed, variable, staff, mode-specific and general operating costs, the total costs while driving are €61,82 per hour. For waiting (cw_i^t), the costs for a trucking company are €38,32 per hour (van der Meulen et al., 2020). During various hours of the night, truck drivers receive more salary than during the day. Thus, the hourly driving and waiting costs per hour of the day vary, as can be seen in table 5.6 (ComitéNationalRoutier, 2019).

Table 5.6: Driving and waiting costs for trucking companies per hour of the day

Hours of the day	Hourly driving costs	Hourly waiting costs
05:00 - 20:00	€61,82	€38,32
20:00 - 21:00	€64,48	€40,98
21:00 - 04:00	€69,71	€46,21
04:00 - 05:00	€67,05	€43,55

The costs per night for a trucking company to use a hub with extended opening hours are set to €5 for a chassis-exchange and €60 for a container hub, as discussed in section 4.3.3. If trucking companies use a hub with extended opening hours instead of visiting a terminal during peak hours, the chance of arriving too late at the hinterland is reduced. Because of this, receivers might consider paying trucking companies some extra money per container for using a hub. The extra amount receivers pay trucking companies for using a hub varies during the simulation runs if the capacity of the hub is not met, as explained in section 6.2.

5.4.3. Data analysis and verification

When analysing the travel times at every hour of the day, the largest and shortest travel times are found at respectively 8:00 in the morning and 00:00 during the night. On average, the travel times at 8:00 are 14.2% higher than the travel times at 00:00. When verifying the travel times, experts at the Port of Rotterdam expected trucks to have a higher difference of travel times between the peak hours (in the morning) and the off-peak hours (at night). One of the reasons the difference is lower than expected could be because Google Maps is calculating travel times in peak hours based on the average travel times in the last two years, while delays in peak hours were fairly higher pre-Covid. Furthermore, Google Maps does not distinguish between passenger cars and trucks. This might also lead to lower travel times during peak hours than the actual travel times of trucks, as trucks often experience more delays than passenger cars when the roads are busy. Since no other data on truck travel times are available and the expected travel times were not too different from the received travel times of Google Maps, these travel times are used for the choice model of trucking companies. All other factors involved in the choice model are checked with experts at the Port of Rotterdam and verified.

5.5. Agent interaction model

Chapter 4 describes the container transport system with all its actors, based on the semi-structured interviews conducted (appendix G). This information is the basis for the agent-based simulation model in this research. This is built by first creating a conceptual agent interaction model, clarifying all important decisions being made in the system. Subsequently, all actors are modelled in Anylogic and are being discussed one by one in section 5.5.2.

5.5.1. Conceptual model

In figure C.1 in appendix C a flow diagram is given to conceptualize the agent-based model. The activities of all actors involved in the transportation of a container between port and hinterland, which are shippers, freight forwarders, trucking companies, truck drivers, terminals and hubs are shown in the figure. All important decisions for these actors, that should be taken into account in the simulation model, are given. However, freight forwards are not taken into account within the simulation model. The reason for this is that freight forwards are only the *middle man* in agreements between shippers and trucking companies. They do not make decisions themselves about (night-time) container transport or influence certain processes. Thus, freight forwards are not needed in the simulation model.

5.5.2. Simulation model

As stated before, the program Anylogic is used for the simulation of container transport. The main reason for this is the face validity of this research. Anylogic gives the option for adding an appealing visualisation of the model. This makes it easier to show results to actors in the system when showing what could be the possible benefits for them of using a hub. When seeing the clear meaning of all scenarios and how it affects them, the chance will be higher for them to change their operations in the future. In figure 5.12, the visualisation of the model is shown. The same zones as the TomTom-data are created in the simulation model and customers are placed in the 42 zones of which the origin-destination data is taken into account. The four container terminals can be seen in red on the left of the Rotterdam area. Furthermore, a possible hub is shown in green. In this example, the hub is located in the Botlek area. Each run of the model simulates all trucks visiting the terminals within 24 hours. The simulation can be run with different seeds, to avoid simulation bias.

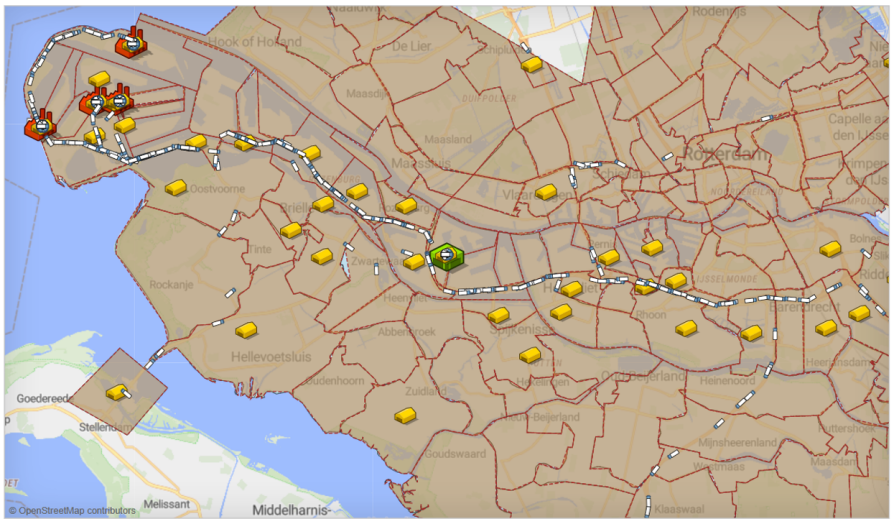


Figure 5.12: Anylogic visualisation

Customer

A customer is added to each of the 42 zones included in the model. The customer agent has a name, which is the zone they are located in, a latitude and a longitude. The customer is placed in the geometric center of the zone it is located in. It represents all customer locations in that zone. A customer creates an order and sends it to a trucking company 24 hours in advance. Since no data is available on different trucking companies, one large trucking company is assumed in the simulation model. How many orders are send by what customers, is based on the trip generation and trip distribution data, discussed in sections 5.1 and 5.3. The order information contains the customer itself and the terminal to be visited. Since the simulation model is on a truck level and not on container level, it does not matter what activity the truck is doing where (e.g., bringing a full important container from terminal to customer, or bringing an empty container from terminal to customer to be filled).

Trucking company

As stated in the previous section, one trucking company is assumed in the simulation model, as no data on different trucking companies (e.g., the number of trucks and how many containers they transport) are available. The trucking company receives the orders from the customers including the terminals to be visited 24 hours in advance. Figure 5.13 shows the process blocks of the trucking company.

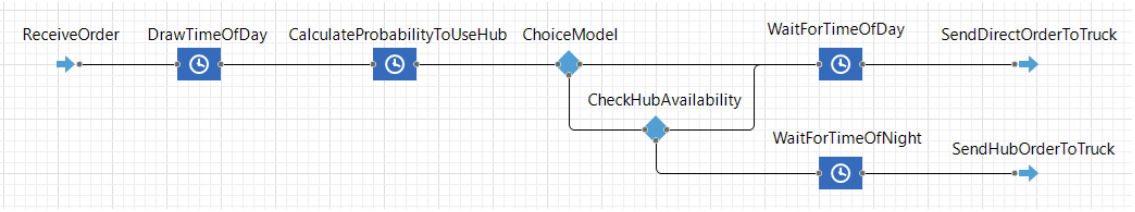


Figure 5.13: Process blocks of a trucking company in Anylogic

After receiving an order, the trucking company draws a time of day from the time of day distribution of the terminal mentioned in that particular order, which are the arrival profiles in the observed data (figure 5.2). The following process of the trucking company is to calculate the probability of using a hub for that terminal-customer pair at the drawn time of day. The *direct route* alternative is chosen with the complement of the calculated probability (1 - P_{hub}). If this alternative is chosen, the direct order is sent to a truck after waiting for the drawn time of day. If the *hub route* alternative is chosen, the availability of the hub is checked so the number of containers using the hub does not exceed the capacity. The priority of using the hub is divided randomly. In reality, if a public hub with extended opening hours is introduced, this will probably be the same, as it depends on which trucking company reserved the hub the earliest. If the hub capacity is not yet reached, the time the truck will visit the terminal is changed to the night. As again no data is known on the time of day choices during the night, the observed time of day distribution of the night hours is used to draw a *time of night*. This distribution is given in figure 5.14.

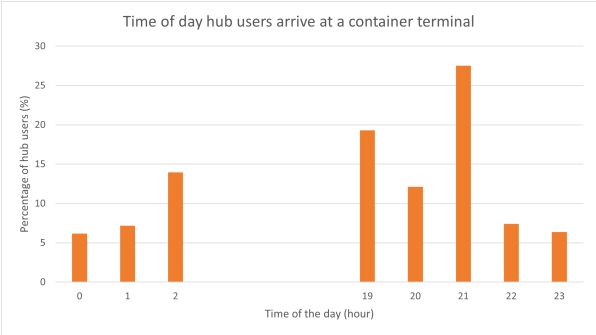


Figure 5.14: Time of day hub users arrive at a container terminal

Truck

If a truck receives an order, it depends on the order what the truck will do. Figure 5.15 gives an example of a truck receiving an order and going through all the steps to be done.

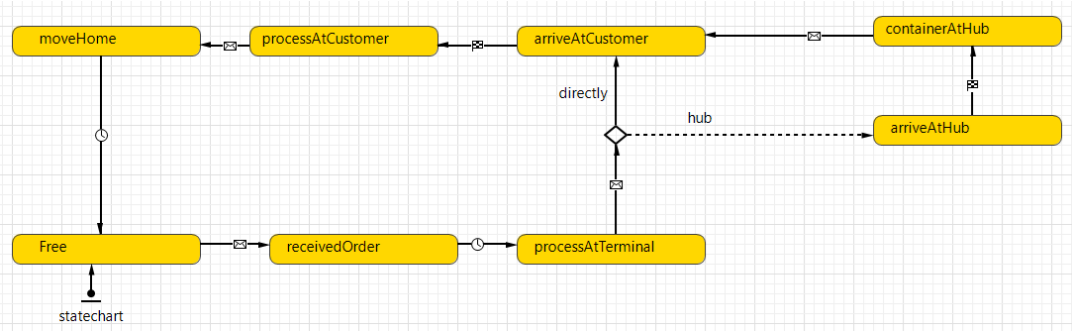


Figure 5.15: Statechart of a truck in Anylogic

The statechart begins in the bottom left. The trucks are located on the Maasvlakte at the terminals. When receiving its order, this truck first enters the terminal process of the terminal mentioned in the order. Following, the truck drives towards the customer or the hub, depending on the choice of the trucking company. After having visited the customer in the hinterland, the truck moves back to its starting location.

Terminal
As discussed in section 5.2, the terminals are queueing models with several gates and exponentially distributed service times. As can be seen in figure 5.16, after arriving at a terminal, the trucks stand in the queue until one of the gates is available for them to be served. After being served, they leave the terminal again.

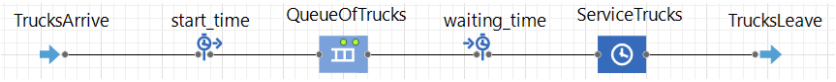


Figure 5.16: Process blocks of a terminal in Anylogic

All terminals have a different number of gates, minimum service time and lambda of the distribution of service times. The values for each terminal, identified with the use of optimization experiments, can be found in table 5.3 in section 5.2.

Hub
A hub with extended opening hours is added on the Maasvlakte or in the Botlek area, depending on the simulation scenario. Other factors of the hub, like its capacity, costs, service time and the type of hub, also depend on the scenario. The scenarios and the values of their variables can be found in section 4.3.3. The time containers spend at a hub depends on the original time of day of the order, as the containers will still be brought to the hinterland at the fixed time of the customer order.

5.6. Assumptions

When modelling the container transport system and the addition of a hub with extended opening hours, several assumptions are taken into account. A list of all assumptions made and their consequences is given below.

- In the simulation model, the arrival and departure patterns at terminals are assumed to be similar to the observed arrival and departure data from the second week in January 2021: Since this was the only week with complete data, the arrival and departure data of all working days were averaged and input for the simulation model. Because of this, the simulated arrivals, departures and waiting times at terminals are based on the number of containers visiting the terminals in that one week in January. If more data would become available, the simulation model could be run with data more similar to the average working day in the whole year 2021.
- The service times at terminals are assumed to be distributed exponentially. In previous research, service times are most often distributed exponentially, as it is far more tractable than other distributions (Hillier and Lieberman, 2010).
- The time a container has to be at the hinterland is fixed: As stated in chapter 4, all trucking companies and shippers have different agreements about their container transport. However, in most cases, receivers give a time a container should arrive at their location. Trucking companies need to adapt their operations so that the arrival time at the hinterland will be met. This results in the fact that when a trucking company uses a hub with extended opening hours for an import container, it will pick up a container at the terminal the night before the fixed time at the hinterland. Whenever a hub is used for an export container, the container will arrive at the terminal the night after. Of course, this is only possible if the container ship the container is leaving on is not leaving the same day as the container is picked up at the hinterland.
- The added hub with extended opening hours is assumed to have no waiting time for trucks to enter the hub processes. First of all, no data is known on the service processes at a hub with extended opening hours and possible waiting times. Second of all, as the hub with extended opening hours has a capacity of much fewer containers than a terminal and trucks can arrive at the hub whenever they want, significant waiting times are not expected.

6 Analyses and results

This chapter includes the analyses and results of the simulation model. Section 6.1 discusses the results of the base case scenario, which is the current situation. Section 6.2 includes sensitivity analyses of the hub costs for trucking companies and results of the hub scenarios stated in section 4.3.3. After that, the system gain, that is the total waiting time gain at all terminals, is discussed in section 6.3. Furthermore, the gain for trucks using a hub with extended opening hours is analysed for every scenario in section 6.4. Lastly, the capital expenditures and the possible costs, revenues and profits of investing in a hub with extended opening hours by various actors are discussed in section 6.5.

During one run of the model, the truck transport between the terminals in the port of Rotterdam and the hinterland is simulated for an average working day of 24 hours. For every result discussed in this chapter, 10 simulation runs with different seeds (1 to 10) are executed to avoid simulation bias. After running these simulations, the results are averaged over all 10 simulation runs. By analysing the results of the base case and comparing these to the results of the hub scenarios, this chapter answers the fourth research question: *What are the possible waiting time gains at terminals' gates from facilitating night-time container transport between port and hinterland using a hub with extended opening hours in several scenarios?*

6.1. Base case

After the model is thoroughly verified and validated (as discussed in chapter 5), the waiting times are analysed for the base case. The base case is the current situation, with no hub added to the system. Since the arrival patterns of an average workday in the second week of January are the input for the model and the model is calibrated using the departure patterns of an average workday in the same week, the model simulates the waiting times during an average workday in that week. Figure 6.1 shows the average simulated waiting times per time of day in the base case.

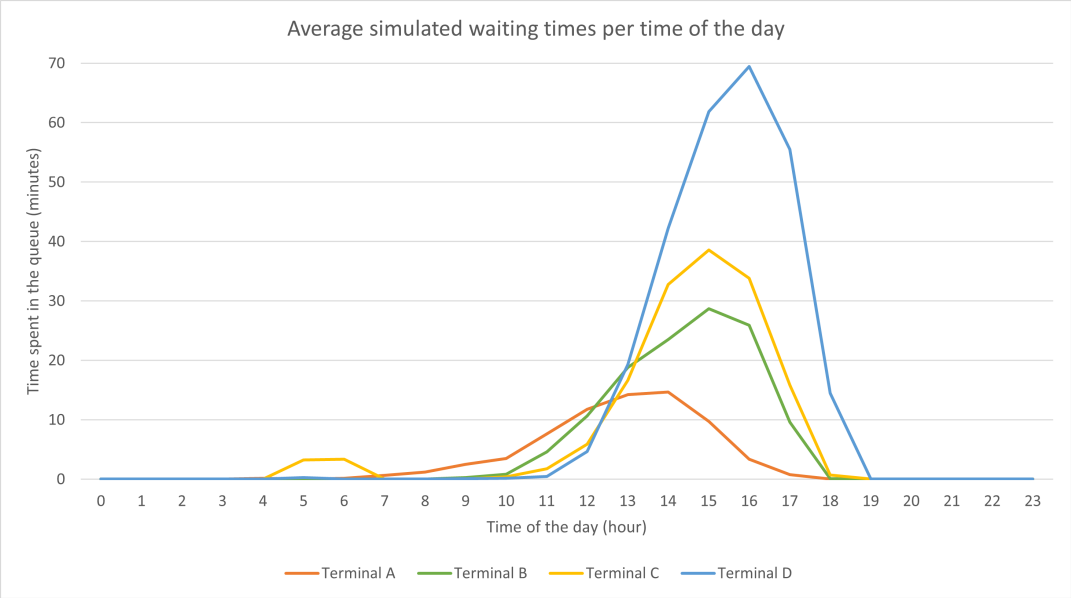


Figure 6.1: Averaged simulated waiting times per time of the day for every terminal

As can be seen in figure 6.1, the waiting times averaged per hour vary between 0 and 70 minutes and differ a lot per terminal. The average waiting times per hour of the day found in the base case are taken into account in the route assignment of trucking companies in the following scenarios (where a hub with extended opening hours is added to the system), as discussed in section 5.4.2. The total waiting times of all trucks in the base case are given in table 6.1 for every terminal. Furthermore, the total costs that belong to these waiting times are calculated using the known average costs for trucking companies that have to wait in front of terminals of €38,32 per hour (van der Meulen et al., 2020).

Table 6.1: Total and average waiting times for all trucks in the base case

Terminal	Total waiting time per day (hours)	Total waiting time costs per day (€)	Total waiting time costs per year (€)
A	65	€2.491	€909.142
B	205	€7.856	€2.867.294
C	313	€11.994	€4.377.868
D	507	€19.428	€7.091.308
Total	1090	€41.769	€15.245.612

As can be seen in table 6.1, the total waiting time of all trucks visiting the four container terminals during an average workday of 24 hours is currently 1090 hours. The total costs for waiting at the terminals are more than €40.000 euros per day and more than €15.000.000 per year. When visiting terminal D, truck drivers experience the longest waiting times before entering the terminal. Terminal A has the lowest total waiting time for its visiting trucks. The next section analyses the waiting times in all hub scenarios. Furthermore, the total operational time of all trucks, of operations that can be modified in the hub scenarios, are analysed. The operations that can be modified in the hub scenarios include waiting in front of a terminal, driving from the terminal to the customer in the hinterland (via a hub in the hub scenarios) and visiting a hub. A trucking company that uses a hub with extended opening hours experiences the service time at a hub two times per container; once when dropping it off and once when picking it up. The total operational time of the stated operations for all trucks within an average working day is 4.139 hours in the base case.

6.2. Hub scenarios

After running the base case, several scenarios are analysed where a hub with extended opening hours is added to the system. The reasoning for the scenarios that are used in this model is stated in section 4.3.3, which resulted in the scenarios shown in table 6.2.

Table 6.2: Scenarios of adding a hub to the model

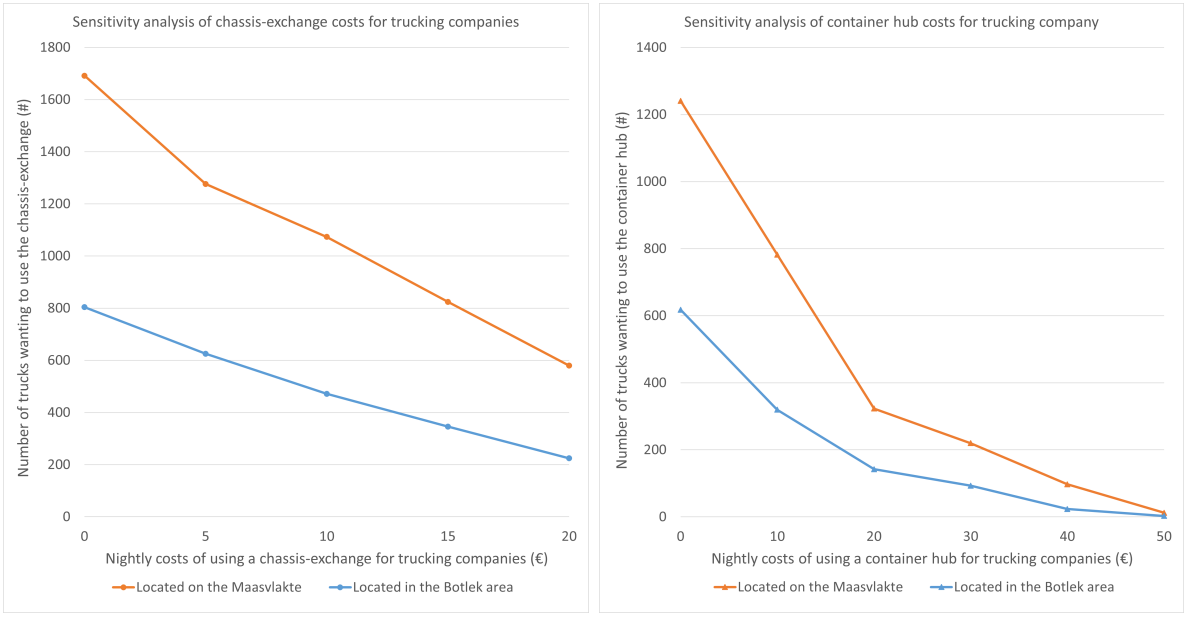
Scenario	Type of hub	Turnaround time (minutes)	Total costs per truck (euros)	Capacity (# of trucks)	Location
1	Chassis-exchange	10	€15 - €20	100	Maasvlakte
2	Chassis-exchange	10	€15 - €20	100	Botlek
3	Chassis-exchange	10	€15 - €20	200	Maasvlakte
4	Chassis-exchange	10	€15 - €20	200	Botlek
5	Container hub	20	€30 - €50	300	Maasvlakte
6	Container hub	20	€30 - €50	300	Botlek

Because the costs per night of using a hub are based on rough calculations and assumptions of experts at the Port of Rotterdam, sensitivity analyses are conducted to research the sensitivity of this parameter. This is done in section 6.2.1. After that, the results of all scenarios are analysed and discussed. Recommendations for conducting sensitivity analyses on other parameters of the simulation model are given in section 7.3.

6.2.1. Sensitivity analyses of hub costs

The costs of a hub with extended opening hours directly influence the number of trucks that wants to use this hub. Because this number might be higher than the capacity of the hub, the costs of the hub do not necessarily affect the waiting times at the terminals. Thus, the sensitivity analyses of the hub costs are conducted analysing the number of trucks that wants to use the hub, to be able to best evaluate the effects of varying the costs of the hub. Furthermore, the choice of trucking companies to want to drive directly between terminal and hinterland or to use the hub is based on the amount of money that they have to pay for using the hub. This is not necessarily the total cost of the hub, as other actors

might choose to pay some amount per container for trucking companies to use the hub. For example, receivers might pay for this, because avoiding the waiting times at the terminals reduces the chance of trucking companies arriving too late at the locations of receivers in the hinterland. By ensuring trucks will arrive on time, the undesired costs for receivers that come with waiting on a container could be decreased. Thus, the sensitivity analyses focus on the costs of using a hub for trucking companies, which could vary between zero (if other actors would pay the total hub costs) and the maximum amount of hub costs. The model is run with these hub costs for trucking companies, without concentrating on what is the total hub costs and what are other actors paying for using the hub. For example, if the hub costs for trucking companies are €10, the total hub costs could be €10 and other actors would pay nothing, or the hub costs could be €30 while other actors are paying €20 per trip. Figure 6.2 shows the sensitivity analyses of the hub costs for trucking companies for using both a chassis-exchange and a container hub.



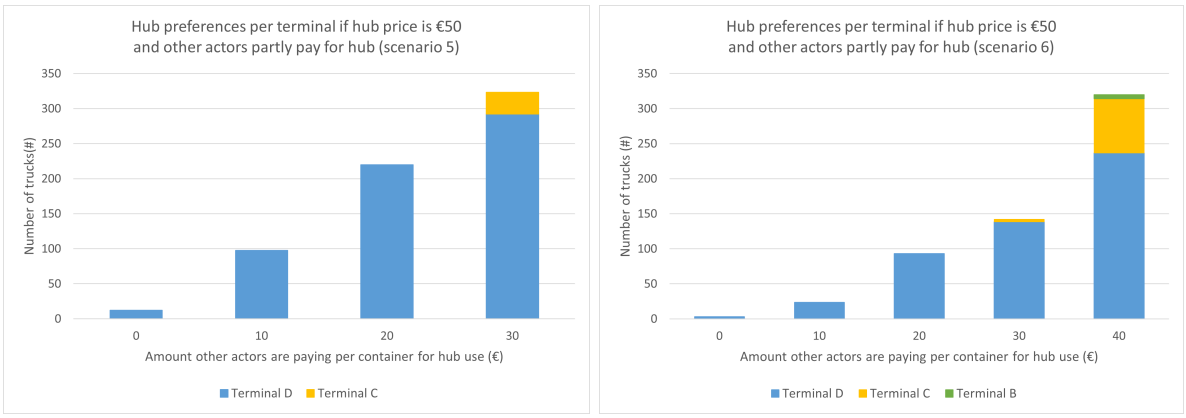
(a) (b)

Figure 6.2: Sensitivity analyses of the hub costs for trucking companies for using (a) a chassis-exchange and (b) a container hub

It can be seen that when a chassis-exchange is introduced with costs for trucking companies varying between zero and €20, the number of trucks that wants to use this hub is always higher than 200, for both a chassis-exchange located on the Maasvlakte and in the Botlek area. Hence, in scenarios 1 to 4, there are always enough trucks choosing the hub route alternative over the direct route alternative to ensure that its full capacity is used. Thus, there is no need for other actors to (partly) pay for trucking companies using a chassis-exchange with extended opening hours. When analysing the results in scenarios 1 to 4, costs of the chassis-exchange of €15 to €20 per are taken into account, while the amount other actors pay for trucking companies using this hub is set to €0. As there are always more trucks that want to use the hub than its capacity, the waiting times at terminals are not affected by the varying hub costs.

Since the container hub has a turnaround time of 20 minutes and the total costs of a container hub are estimated between €30 and €50 euro, this type of hub is less appealing to trucking companies than a chassis-exchange when they make their decision to use a hub based on their total costs and time needed per trip. Figure 6.2 shows that if the costs of using a container hub for trucking companies are varying between €30 and €50, the number of trucks that want to use the hub varies between 12 and 220 for a container hub on the Maasvlakte. For a container hub located in the Botlek area, this number varies between 3 and 93 trucks. As the waiting times at terminals for 100 and 200 hub users of a hub with extended opening hours are already calculated in scenarios 1 to 4, scenarios 5 and 6 evaluate the results of a container hub with a capacity of 300 trucks that is fully used. Thus, in those scenarios, it is assumed that other actors partly pay for trucking companies using the container hub. As can be seen in the sensitivity analysis of the container hub costs, the full capacity of a container hub on the Maasvlakte is used if the costs of using this hub for trucking companies are around €20 or lower. For a container hub in the Botlek area, the capacity is fully used when the costs of using this hub for trucking companies are around €10 or lower. Thus, depending on the total hub costs, other actors pay between €10 and €30 per trip for trucking companies using a container hub on the Maasvlakte (scenario 5) and between €20

and €40 for trucking companies using a container hub in the Botlek area (scenario 6). Figure 6.3 shows the number of trucks that want to use the container hub (also called the *hub preferences*) per amount other actors pay for using the hub if the total costs of using the container hub would be €50, which is the maximum estimated costs of a container hub.



(a) **(b)**

Figure 6.3: Hub preferences per terminal if total hub costs are €50 and other actors partly pay for using the hub in (a) scenario 5 and (b) scenario 6

Figure 6.3 shows that other actors have to pay up to €40 for trucking companies using a container hub to ensure that 300 trucks want to use the container hub. As stated by a terminal during an interview (section G.3), the average number of containers being brought and picked up during the terminal visit of 1 truck is 1,32. The reason for this is that even though there are some empty trips, some trucks carry multiple containers and most importantly, trucking companies try to combine multiple containers in one trip. As hub visits can also be combined, one hub visit corresponds with on average 1,32 containers. Because of this, depending on the total hub costs, the amount that other actors would have to pay for trucking companies using the container hub will be between €7.58 and €22.73 per container in scenario 5 and between €15.15 and €30.30 per container in scenario 6. It is not very presumable that a lot of receivers would pay up to €30.30 per container for trucking companies for using a container hub to reduce the chance of trucks arriving at the hinterland too late. However, it is still possible if for example the content of a container is very valuable and it is important that it has to arrive on time. Furthermore, other actors could also partly pay for trucking companies to use the hub because they want to reduce waiting times at terminals. Chapter 7 further discusses the possibilities of implementation of other actors paying for trucking companies to use the hub. As argued before, scenarios 5 and 6 are run assuming other actors partly pay for trucking companies using the container hub, so the hub costs for trucking companies are respectively €20 and €10 so the capacity of the hub will be fully used. The results of scenarios 1 to 6, including the number of trucks that want to use the hub, number of hub users and total waiting time per terminal are presented in appendix B. Also, the total operational time of trucks waiting at terminals, driving to customers and visiting a hub, as well as figures of the average waiting times per time of the day are given per scenario. All scenarios are run with seeds 1 to 10 to avoid simulation bias.

Total waiting times

In table 6.3 the hub preferences show the number of trucks that wants to use the hub if they would have to pay the total hub costs. The * next to the hub preferences of scenarios 5 and 6 signifies that because these numbers are lower than the hub capacity, scenarios 5 and 6 assume that other actors partly pay for trucking companies using a hub so the capacity of the hub is fully used. In scenario 5, depending on the total costs of the hub, other actors pay €10 to €30 per truck that moves from driving directly to using the hub, so that the hub costs for trucking companies are €20. In this case, the number of trucks that want to use the hub is 323, which exceeds the hub capacity of 300. In scenario 6, other actors pay €20 to €40, so that the hub costs for trucking companies are €10. In that case, the number of trucks that want to use the hub is 320, which also exceeds the hub capacity of 300. Chapter 7 discusses the possibilities of implementation of other actors paying for trucking companies to use the hub. Furthermore, the number of hub users, the total waiting time at all terminals and the total operational time gain of trucks that use the hub (including the waiting time, driving time and hub time) are given in table 6.3 for every scenario. In the base case, the total waiting time per day was 1.090 hours.

Table 6.3: Results per scenario

Scenario	Hub preferences (# of trucks)	Hub users (# of trucks)	Total waiting time per day (hours)	Operational time gain per day (hours)
1	580 - 1.276	100	852	15
2	225 - 625	100	876	10
3	580 - 1.276	200	670	33
4	225 - 625	200	717	20
5	12 - 220*	300	751	54
6	3 - 93*	300	664	-29

The next sections discuss the results for both the chassis-exchange and the container hub scenarios, including the waiting times of all trucks at the terminals and the operational time gain for the trucks using the hub.

6.2.2. Chassis-exchange

Scenarios 1 to 4 analyse the effects of introducing a chassis-exchange to the container transport system between the port of Rotterdam and its hinterland. Both the Maasvlakte and the Botlek are evaluated as locations for the chassis-exchange. Capacities of 100 and 200 trucks are tested. The reason for testing both capacities is that the capacity influences the capital expenditures (CAPEX) of building a chassis-exchange a lot. Investors in such a chassis-exchange might choose to build 100 or 200 parking spots, depending on the difference in waiting time gain. Naturally, the scenarios with a capacity of 200 trucks lead to lower waiting times and thus higher waiting time gains, than the scenarios with a capacity of 100. However, the difference in waiting time gain is interesting for actors involved in building and investing in a future chassis-exchange. Both the effects of the location and the capacity of a chassis-exchange are discussed below.

Location

When analysing the results, the chassis-exchange that was located on the Maasvlakte (scenarios 1 and 3) was more popular than the chassis-exchange located in the Botlek area (scenarios 2 and 4). After calculation of the probability of using a hub for every truck, the number of trucks that want to use the chassis-exchange located on the Maasvlakte is 580 to 1.276 trucks, depending on the hub costs. The number of trucks that want to use the chassis-exchange located in the Botlek area is lower, namely 225 to 625 trucks. The reason for this is that all container terminals are located on the Maasvlakte, which means that for all trucks, the chassis-exchange on the Maasvlakte is not a large detour. Thus, when waiting times are high, the probability of using a chassis-exchange on the Maasvlakte quickly increases for many origin-destination pairs. The chassis-exchange in the Botlek area is further away from the container terminals. However, it is still on the route between the Maasvlakte and a lot of hinterland locations. Thus, also this location leads to more demand than the capacity of the chassis-exchange.

The total waiting times at all terminals between a chassis-exchange on the Maasvlakte and in the Botlek area do not differ a lot. The reason the waiting times at terminals are different depending on the location of the hub is that depending on the location, other trucks want to make use of the hub. If the number of trucks that wants to use the hub is higher than the capacity of the hub, it is randomly distributed whoever of the trucks that want to use the hub, gets to use the hub. The reason for this is that if a public hub is introduced, the trucking companies that reserve the hub the earliest, get priority in using the hub. Thus, with more trucks that want to use the chassis-exchange on the Maasvlakte, trucks from diverse times of day make use of the hub, which has a positive effect on the total waiting time in scenarios 1 to 4. The operational time gain of trucks that use the hub is higher in the scenarios where a chassis-exchange is located on the Maasvlakte. The reason for this is that this hub is less of a detour for the trucks travelling between terminals and the hinterland. Because of the operational time gain, the trucking company can possibly make more trips. Section 6.4 discusses the gain of a hub user more thoroughly.

Capacity

As expected, the number of trucks that wants to use the chassis-exchange does not change when the capacity is increased. As stated before, increasing the capacity of a chassis-exchange from 100 (scenarios 1 and 2) to 200 (scenarios 3 and 4) leads to more waiting time gain. As can be seen in table 6.3, in scenarios 3 and 4 the total waiting time has decreased by almost double the amount of total waiting time reduction in the first two scenarios. Also, the operational time gains in scenarios 3 and 4 have almost doubled compared to scenarios 1 and 2. However, the CAPEX of creating a chassis-exchange of 200 trucks is also almost double the CAPEX of creating a chassis-exchange with a capacity of 100 trucks. Investors should determine what they are willing to spend on solutions for waiting time gain at container terminals. Section 6.5 further discusses the investment in a hub with extended opening hours by several possible actors.

6.2.3. Container hub

Scenarios 5 and 6 analyse the effects of introducing a container hub to the container transport system between the port of Rotterdam and its hinterland, where the location of the hub varies in the two scenarios. As a container hub has more capacity, it might be interesting for facilitating a large amount of night-time container transport. However, experts estimate that the turnaround time will be around 20 minutes and that the total costs for a container hub are between €30 and €50. As stated before, other actors need to partly pay for trucking companies using the container hub, so that enough trucks are willing to use the hub. The value that other actors have to pay to trucking companies for the capacity of the hub to be met is lower when the container hub is located on the Maasvlakte than when it is located in the Botlek area. Thus, it can be concluded that like in the scenarios with a chassis-exchange, more trucks want to use a hub located on the Maasvlakte compared to a hub located in the Botlek area. Even though scenarios 5 and 6 assume that other actors have to pay for trucking companies using a container hub, those scenarios do not result in much higher waiting time gains compared to the scenarios where a chassis-exchange is introduced. The total waiting time in scenario 5 is even higher than the total waiting time in scenario 3. A possible reason for the waiting times not being much better in scenarios 5 and 6, could be that since only a few trucks have a high probability of using the container hub, trucks that all arrive at the terminals at the same hours (between 16:00 and 18:00) are going to use the hub. If only these hours get a lower number of truck arrivals, only the waiting times at those hours disappear and not much gain at other times of the day will be established. However, the operational time gain is quite a bit higher in scenario 5 than in scenario 3. The operational time gain of scenario 6 is discussed in the next paragraph.

Location

The number of hub preferences in scenarios 5 and 6 can not be compared, as the trucking companies get paid around €10 more by other actors for using the container hub in scenario 6. The total waiting times of a container hub located on the Maasvlakte and in the Botlek area do not differ much. As in scenarios 1 to 4, the difference occurs because of the different trucks that use the hub. The total operational time of trucks waiting at terminals, driving between terminals and the hinterland and using the hub, is much lower in scenario 5 compared to scenario 6. The total operational time of trucks using the hub in scenario 6 is even higher than in the current situation, as the operational time gain is negative. A reason for this could be that not a lot of trucks want to use this hub, because of the costs and hub time. As other actors pay for using this hub, some trucks (with very high waiting times) choose to use the hub. However, the hub in the Botlek area is probably not on the route between the origin and destination of most of these trucks. Thus, the total operational time of these trucks can become negative as they have to make detours.

6.3. System gain

6.3.1. Total waiting time gains

The total waiting time gains of all scenarios are given in table 6.4. Furthermore, the monetary gains that belong to the waiting time gains are calculated with the waiting time costs of €38,32 per hour (van der Meulen et al., 2020). As stated before, the * next to scenarios 5 and 6 signifies that other actors partly pay for the hub costs so the hub capacity is fully used. Thus, this should be taken into account when comparing the scenarios. In the base case, the total waiting time at all terminals was 1090 hours, which corresponds with waiting time costs of €41.769 per day and €15.245.612 per year.

Table 6.4: Waiting time gain per scenario

Scenario	Total waiting time gain (hours)	Total monetary gain per day (€)	Total monetary gain per year (€)
1	239	€9.158	€3.342.845
2	212	€8.130	€2.967.379
3	421	€16.133	€5.888.443
4	373	€14.293	€5.217.076
5*	338	€12.952	€4.727.538
6*	425	€16.286	€5.944.390

All scenarios of introducing a hub with extended opening hours to the container transport system create a total waiting time gain of 212 to 425 hours. When calculating the total monetary gain corresponding with this waiting time gain, introducing a hub can lead to gains of around 3 to 6 million euros per year. Since other actors have to pay trucking companies for using the container hub for the hub to be fully used in scenarios 5 and 6 and the waiting time gains are not much higher than in scenarios 3 and 4, scenarios 5 and 6 are less popular when searching for a solution that is

implemented easily. As can be seen in table 6.4, scenario 3 is the chassis-exchange with the highest total waiting time gain. The total monetary gain because of reduced waiting times in this scenario is more than €16.000 per day, which leads to a total monetary gain of almost €6.000.000 per year. This is almost 40% of all current waiting time costs, there were found in the base case. All trucks arriving at the terminals during peak hours profit from the waiting time gain. How this gain could be distributed, is discussed in section 7.1. Section 6.3.2 presents all results of the simulation runs of scenario 3.

6.3.2. Most promising scenario

Scenario 3 evaluates the effects of introducing a chassis-exchange on the Maasvlakte. The capacity for the hub is set to 200 trucks and the turnaround time at the hub, which is the time it takes to remove one chassis and attach another chassis, is 10 minutes. The total costs per night for a trucking company using the hub is varied between €15,00 and €20,00. Table 6.5 shows the number of trucks that wants to use the chassis-exchange on the Maasvlakte, the number of trucks actually using it and the total waiting time per terminal.

Table 6.5: Results of scenario 3

Terminal	Hub preferences (#)	Hub users (#)	Total waiting time (hours)	Total waiting time gain (hours)	Total monetary gain per day (euros)	Total monetary gain per year (euros)
A	0 - 26	5	57	8	€307	€111.894
B	21 - 389	62	95	110	€4.215	€1.538.548
C	160 - 402	62	194	119	€4.560	€1.664.429
D	399 - 459	71	323	184	€7.051	€2.573.571
Total	580 - 1.276	200	670	421	€16.133	€5.888.443

As can be seen in table 6.5, the highest waiting time gain is experienced by trucks visiting terminal D. Figure 6.4 shows the average waiting time per hour of the day for all terminals in scenario 3 and the base case.

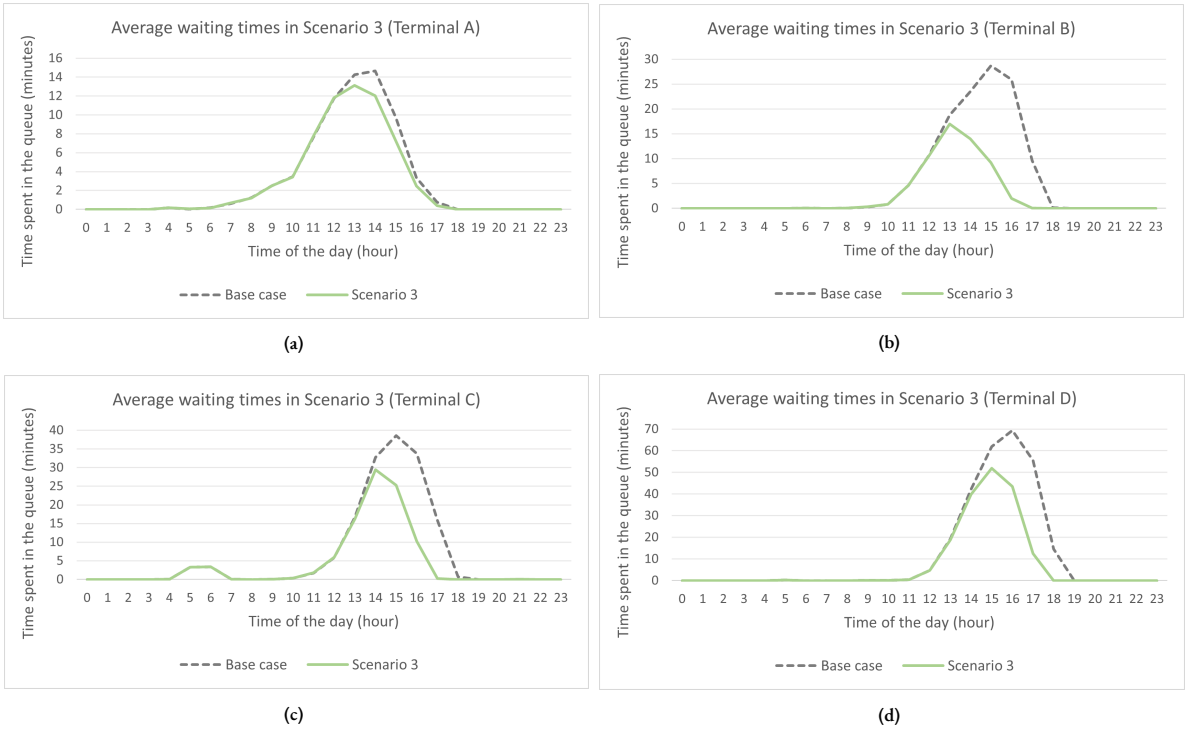


Figure 6.4: Averaged simulated waiting times per time of the day for every terminal in scenario 3

Figure 6.4 shows that the waiting times at all terminals are reduced, especially during and just after the time of day that currently has the highest waiting times. As the y-axis of the graph of terminal D has higher values than the other graphs, it can be seen that terminal D has the highest waiting time gain in this scenario. The total operational time gain for the

trucks that use the hub with extended opening hours to wait in front of the terminals, drive between the terminals and the hinterland and visit the hub, is 42 hours on an average workday in scenario 3. The next section will elaborate on the benefits of the operational time gain for trucking companies.

6.4. Operational time gain of hub users

All trucks visiting container terminals profit from the total waiting time gain, which is thus called the system gain of introducing a hub with extended opening hours. However, trucks using the hub with extended opening hours also profit from an operational time gain. This gain is discussed in the following sections.

6.4.1. Total operational time gains

As discussed in previous sections, the total operational time of all trucks is compared to the base case in all scenarios. Table 6.6 gives the total operational time gains per day and year for every scenario. This table only includes the operational time gain for the trucks using the hub, not the time gain the other trucks perceive because of lower waiting times. Thus, this number includes the time gain of trucks waiting at terminals' gates, driving between the terminals and the hinterland (via the hub) and visiting the hub. As stated before, the * next to scenarios 5 and 6 signifies that other actors partly pay for the hub costs so the hub capacity is fully used, which should be taken into account when comparing the scenarios.

Table 6.6: Operational time gains per scenario

Scenario	Operational time gain per day (hours)	Operational time gain per year (hours)
1	15	5.475
2	10	3.650
3	33	12.045
4	20	7.300
5*	54	19.528
6*	-29	10.585

As can be seen in table 6.6. The operational time gain of trucks using the hub in scenario 6 is negative. This means that the total operational time of trucks using the hub is higher than when they would drive between the terminals and hinterland directly. A reason for this could be that not a lot of trucks want to use this hub, because of the costs and hub time. As other actors pay for using this hub, some trucks (with very high waiting times) choose to use the hub. However, the hub in the Botlek area is probably not on the route between the origin and destination of most of these trucks. Thus, the total operational time of these trucks can become negative as they have to make detours. In scenario 1, it is possible to say that if trucking companies would for example need 3 hours to complete one tour, 5 extra tours could be transported per day and 1825 extra tours could be made during a whole year. However, profiting from the operational time gain is not as simple as that. If multiple trucking companies would make use of the hub, the operational time gain should be distributed over all trucking companies using the hub. Furthermore, one trucking company should have enough time gain to fit another tour in the planning. Section 6.4.2 gives an example of how a trucking company could profit from using the hub.

6.4.2. Example of implementation

As determined with the use of semi-structured interviews with trucking companies (appendix G.1), various trucking companies perform different types of container transport. One company could carry out mostly long-distance transport, while others stay within short distances of the port. A lot of factors could influence the way a trucking company could profit from using a hub with extended opening hours. Figure 6.5 gives an example of a truck transporting containers between the port of Rotterdam and the hinterland from 8:00 to 20:00. This company plans its operations very efficient, as they do not drive between a terminal and the hinterland empty. The hinterland this truck is visiting is located 30 minutes from the terminal. However, the traffic during the day ensures a travel time of 35 minutes between the terminal and the hinterland. In this case, it takes 90 minutes to unload a container at a customer in the hinterland and it takes 30 minutes to pick up a new container, possibly at another location in the hinterland. Thus, if doing both, the container spends 2 hours in the hinterland, before returning to one of the terminals. As can be seen in figure 6.5, it takes 20 minutes to visit a terminal to pick up one container. As being stated by two trucking companies (TruckingCompanies, 2021), it takes (at least) 40 minutes to visit a terminal where a container is dropped off and another container is picked up. Because of the current waiting times at terminals (see section 6.1), this truck needs to wait 10 minutes in front of a terminal at

11:30 and 60 minutes at 16:00. Thus, this truck can transport 3 import containers from a terminal to a customer in the hinterland and transport 2 export containers from the hinterland to a terminal. If for example, a trucking company owns 25 trucks that transport containers like this example, the trucking company can transport 75 import containers and 50 export containers per day.

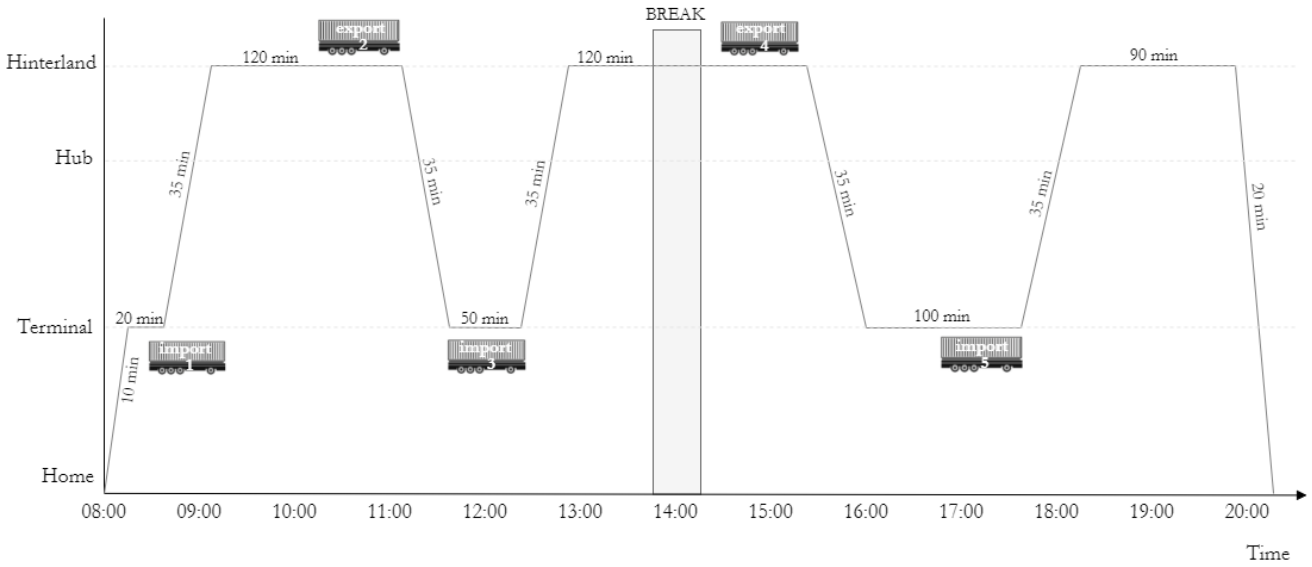


Figure 6.5: An example of a truck transporting containers for 12 hours at daytime in the current situation

Now, a hub with extended opening hours is added to the container transport system. In this example, it is a chassis-exchange that is located in the Botlek area, which is on average a 25-minute drive from the terminals, without traffic. The travel time between the hub and the hinterland is on average 5 minutes without traffic. If a hub is introduced to the system, the trucking company could choose to let one of their trucks transport containers at night between the terminals and the hub. The best option for the trucking company would be to let this truck transport the containers to the hub that are currently being picked up at the terminals at 16:00 (when the waiting time is 60 minutes). The containers being transported from the hub to the terminals are the ones that are normally being delivered at the terminals at 16:00. Figure 6.6 shows a truck transporting containers between the terminals and the hub at night.

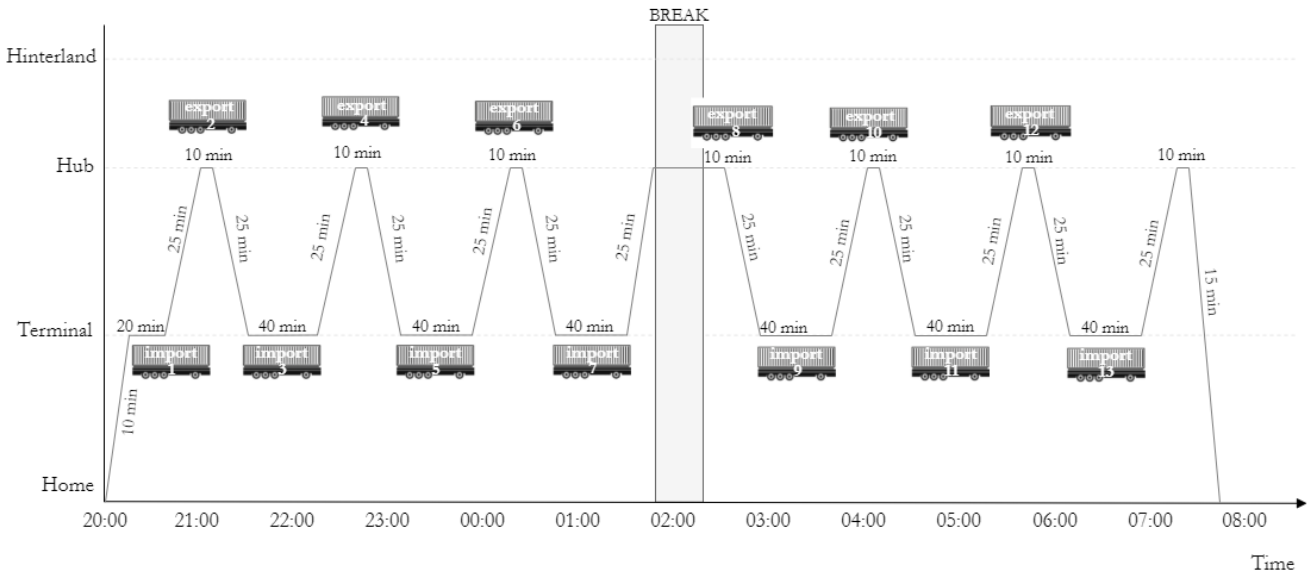


Figure 6.6: An example of a truck transporting containers for 12 hours at night-time in a situation with a hub

Since the hub with extended opening hours is a chassis-exchange, truck drivers receive a container at a terminal and deliver it to the hub together with the chassis. Then, they pick up a new container with chassis that was delivered from the hinterland to the hub the day before. Thus, some extra chassis need to be bought to be stored at the chassis-exchange. However, a new chassis does not have to be acquired for every container, as trucks that are using the hub can leave their current chassis at the hub to be used. The same period (12 hours) is used as the truck transporting containers during the day. This does not necessarily mean that one truck driver is doing all this transport, but this lets the operations of 1 truck be compared. As can be seen, this truck can transport 7 import containers and 6 export containers between the terminal and the hub between 20:00 and 08:00. Because of the 7 import containers and 6 export containers being transported between the terminals and the hub during the night, 6 trucks that are driving in the daytime do not need to visit the terminal during the busiest peak hours (between 13:00 and 18:00). Instead of visiting the terminal at that time, it brings the second export container to the hub (to be transported to the terminal at night) and picks up the third import container (that has been transported there the night before). This can be seen in figure 6.7.

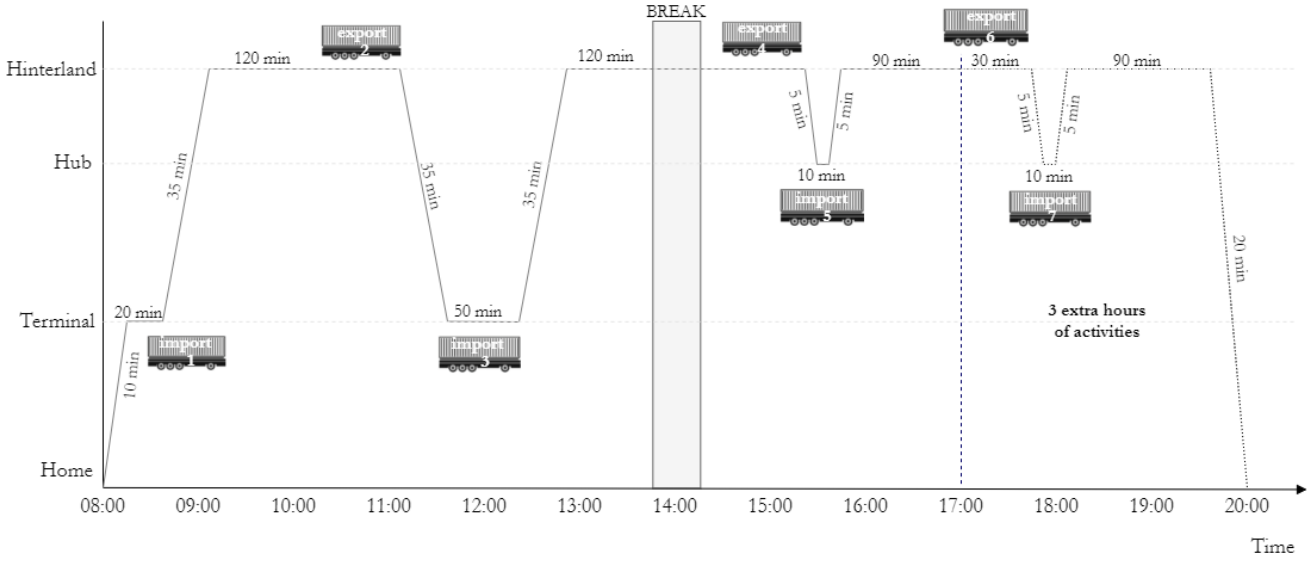


Figure 6.7: An example of a truck transporting containers for 12 hours at daytime in a situation with a hub

As a result of visiting the hub instead of the terminals during the busiest peak hours, these 6 trucks have 3 extra hours in the same 12-hours span. In these 3 hours, they can do extra activities, like picking up a new container from the hinterland, bringing it to the hub and delivering another container from the hub to the hinterland. The truck that moved from the daytime to the night-time transports 3 import containers and 2 export containers less between the terminals and the hinterland. However, it enables 7 trucks to transport 1 more import container and 6 trucks to transport 1 more export container. During 24 hours, 4 more important containers (7 - 3) and 4 more export containers (6 - 2) can be transported by using the hub, with the same operational hours of the trucks. If this trucking company would receive €190 for transporting one container, which is the average amount a trucking company located in Rotterdam receives per container (TruckingCompanies, 2021), the use of the hub would lead to an operational time gain of €1.520 per day, for only moving one truck to the night. Of course, this amount would be different for every example, but this gives a possibility for trucking companies to take advantage of using a hub with extended opening hours. A challenge for some trucking companies can be the fact that the demand for transport varies over the days. However, when appointing a truck driver to night-time transport, the demand for night-time transport should be high enough on all days. Section 7.1 discusses this challenge more thoroughly. The next section discusses the costs, revenues and profits of investing in a hub with extended opening hours. As this could be done by one or more trucking companies, the hub user time gain is taken into account and more gains of the trucking companies investing in and using the hub are clarified.

6.5. Investing in a hub with extended opening hours

A challenge of a hub with extended opening hours, which is one of the main reasons that no shared hub is currently implemented today, is the investment in a hub. This research mainly focuses on the operating costs of a hub as it investigates when, that is with what hub characteristics, would a truck want to make use of the hub. As this research states that implementing a hub with extended opening hours leads to both system-wide waiting time gains and operational time gains for trucks using the hub, it would be profitable for trucking companies if a hub was introduced in the container transport system. As stated in 4.3, also other actors profit from reduced waiting times at container terminals. All the actors profiting from a hub with extended opening hours could invest in the construction of such a hub if they have enough money for the capital expenditures (CAPEX). For example, a large trucking company could build a private hub to facilitate its own night-time container transport. As found in the interviews (appendix G), some trucking companies already use their own facility to store containers during the night. If several trucking companies identify the gains of using a hub with extended opening hours for them, they could decide to invest in a hub together. This could for example be co-financed by for example the Port of Rotterdam or a terminal. These actors could also decide to fully finance and build a hub with extended opening hours in the port area themselves. Another option is that receivers of containers in the hinterland, located on the same industrial area, create a hub with extended opening hours on this industrial area, for all their containers to use. The structure of actors financing a hub influences how this hub should be created. For example, what its location and capacity should be. After discussing the CAPEX of building a hub, this section discusses the costs, revenues and profits of investing in a hub with extended opening hours for various actors.

6.5.1. Capital expenditures

As stated by a terminal during an interview (section G.3), the average number of containers being brought and picked up during the terminal visit of 1 truck is 1,32. The reason for this is that even though there are some empty trips, some trucks carry multiple containers and most importantly, trucking companies try to combine multiple containers in one trip. Thus, if 100 trucks that visit the terminal choose to use the chassis-exchange per day (scenarios 1 and 2), 132 containers pass the hub during one night. If trucks arrive at the hub with a chassis with a container and need to pick up another one, they switch the chassis with a container so that they use the same parking place. Thus, for 100 truck visits and 132 containers, 100 parking places are needed at the chassis-exchange. As discussed in section 4.3.3, the costs of buying a chassis lay around €4.000. Depending on how trucking companies precisely organize switching the chassis, the amount of new chassis needed when building a chassis-exchange is estimated to be around 90% of the parking places it has. The other 10% of containers can be stored on the existing chassis of the trucks that will use the hub. This leads to costs of buying new chassis of around €360.000 for a chassis-exchange with 100 parking places (scenarios 1 and 2). For a chassis-exchange with 200 parking places, these costs are estimated to be around €720.000. As stated in section 4.3.3, the costs of buying a reach stacker are on average around €200.000. If a container hub with space for 300 truck visits (corresponding to 395 containers) would need 10 reach stackers to move containers at the busiest times of the day, the costs of buying these reach stackers would be around €2.000.000. The costs of buying chassis and reach stackers have to be taken into account for the capital expenditures (CAPEX) of building a chassis-exchange and a container hub. Furthermore, other costs have to be taken into account, like the ground costs and costs for installing security like a fence and cameras. According to the investigation of MoVe for the research on a possible chassis-exchange for reefer containers, these costs are estimated to be around €10.000 per parking place (PortOfRotterdam, 2021a). A study should be executed on the exact capital expenditures for building a chassis-exchange and container hub. However, more important in the long term are all the costs and revenues that owners of the hub experience every day. The following sections discuss these for when different actors would invest in a hub with extended opening hours.

6.5.2. Costs, revenues and profits of investing in a hub

First, the costs, revenues and profits of one or more trucking companies investing in a hub with extended opening hours are discussed. After that, the investments of other actors are discussed.

Trucking companies

Trucking companies would profit the most from using a hub, as they experience lower waiting times at container terminals, as well as an operational time gain because of the shorter Maasvlakte visits and lower travel times at night. These operational time gains could lead to the transportation of more containers. One or more trucking companies could choose to invest in a hub with extended opening hours, to be used by their own trucks. This section discusses the total estimated costs, revenues and profits of all trucking companies investing in the hub. Thus, if several trucking companies invest in a hub together, these profits should be divided over them. First of all, the costs and revenues of all trucks switching from a direct to hub route in the simulation model are shown in table 6.7. The second column of this table shows the hub costs per truck. As explained thoroughly in section 4.3.3, the hub costs of a chassis-exchange for trucking

companies are estimated to be between €15 and €20 per truck, of which around €14 belongs to the time it takes to use the hub. Thus, €1 to €6 belongs to ground and maintenance costs. As the amount of ground and maintenance costs are unsure and for example depend on if the Port of Rotterdam will charge ground costs or not because they want to participate in better facilitating night-time container transport, the hub costs per truck vary between €15 and €20. The total hub costs for trucking companies using a container hub (scenarios 5 and 6) are estimated to be €30 to €50, of which around €28 belongs to the time it takes to use the hub. Thus, €2 to €22 belongs to ground, maintenance and reach stacker operator costs. In the sensitivity analyses in section 6.2.1 it was stated that 300 trucks only want to use the hub if the costs for trucking companies would be €20 or lower in scenario 5 and €10 or lower in scenario 6. However, since trucking companies would own the hub themselves in this case, they might still want to use the hub if it would lead to profits for them. Thus, table 6.7 shows the costs and revenues of trucks using the hub if the costs of a container hub would be €30 to €50 in scenario 5 and 6 and 300 of their trucks use the hub. Furthermore, as concluded in section 6.2.1, also scenarios 5* and 6* are shown. These scenarios assume other actors than the trucking companies would have to pay €10 to €30 per truck to the trucking companies in scenario 5 and €20 to €40 per truck in scenario 6, so the hub costs for trucking companies does not exceed €20 and €10, respectively. This leads to around €7.58 to €22.73 per container in scenario 5 and €15.15 to €30.30 per container in scenario 6. The reason for this is explained in section 6.2.1. Because of other actors partly paying for using the hub, the total costs of the hub for trucking companies are reduced from €9.000 to €6.000 in scenario 5* and €3.000 in scenario 6*. The reason for receivers to partly pay for trucking companies to use the hub could be to ensure that their containers are delivered on time at their location. Other actors might choose to pay this amount because they want to reduce the waiting times at terminals. For scenarios 1 to 4 and 5 and 6 without *, no other actors need to pay for trucking companies using the hub.

Table 6.7: Total costs and revenues of the trucks using the hub with extended opening hours per day

Scenario	Hub costs per truck	Hub users (# of trucks)	Total hub costs	Total extra driving costs	Waiting time gain	Total gain per day
1	€15 - €20	100	€1.500 – €2.000	€504	€2.338	- €166 – €334
2	€15 - €20	100	€1.500 – €2.000	€1.269	€2.817	- €452 – €48
3	€15 - €20	200	€3.000 – €4.000	€991	€4.732	- €259 – €741
4	€15 - €20	200	€3.000 – €4.000	€2.555	€5.652	- €903 – €97
5	€30 - €50	300*	€9.000 – €15.000	€1.573	€11.095	- €5.478 – €522
6	€30 - €50	300*	€9.000 – €15.000	€3.420	€9.866	- €8.554 – - €2.254
5*	€20*	300	€6.000*	€1.573	€11.095	€3.522
6*	€10*	300	€3.000*	€3.420	€9.866	€3.447

Furthermore, the total extra driving costs that are being made because of all trucks using the hub (depending on their origin and destination) and the costs that are reduced due to avoiding the long waiting times at the terminals (depending on which terminal these trucks visit and from which times of day they are switching to the night) are given in table 6.7. The last column, which shows the total revenues per day of the trucks using the hub, adds up the extra driving costs, the hub time costs and the other hub costs and subtracts these from the reduced waiting time costs. It can be seen that because of the varying hub costs, the total gains of all trucks using the hub could either be negative or positive in scenarios 1 to 6. In scenarios 5* and 6* the total gains of all trucks using the hub are positive. However, it should be kept in mind that other actors need to pay €7.58 to €30.30 in these scenarios.

Apart from the costs and revenues of the trucks using the hub with extended opening hours, new revenues occur for the trucking companies using the hub because of operational time gains. Section 6.4 discusses these gains and gives an example of how trucking companies could use these. Table 6.8 shows the total operational time gain for all trucking companies using the hub. Using the total operational time of these trucks when they drive directly between a terminal and the hinterland (the current situation), including an average time in the hinterland of one hour, the average time per trip is calculated. This average time per trip can be different per scenario, as trucks with different origin-destination pairs use the hub in the various scenarios. With the average time per trip, the extra number of trips that can be made because of the operational time gain is given per scenario. If trucking companies would receive €190 for transporting one container, which is the average amount a trucking company located in Rotterdam receives per container (TruckingCompanies, 2021) and the average number of containers transported per trip is 1,32 (appendix G.3), the revenue is €250,80 per extra trip. Since this amount is based on information from one trucking company, the revenue per extra trip is varied between €200 and €300. These amounts are used to calculate the estimated new revenues per day because of the operational time gain for every scenario. The revenues in table 6.8 are found with the total operational time gain of all trucks using

the hub. Thus, if five trucking companies own the hub, these extra trips should be divided over them.

Table 6.8: Estimated new revenues per day because of the operational time gain due to using the hub

Scenario	Operational time gain (hours)	Time per trip (hours)	Extra trips per day (#)	Revenue per day (euros)
1	15	2.6	5	€1.000 – €1.500
2	10	3.2	3	€600 – €900
3	33	2.7	12	€2.400 – €3.600
4	20	3.2	6	€1.200 – €1.800
5	54	3.0	18	€3.600 – €5.400
6	-29	3.3	-9	-€2.700 – -€1.800

It can be seen in table 6.8 that in almost all scenarios, the operational time gain leads to new revenues per day. Only in scenario 6 where other actors pay for trucking companies using the hub so that the hub capacity is fully used, the total operational time is higher than in the current situation. As fewer containers can be transported per day, this leads to fewer revenues for the trucking companies. A reason for this could be that not a lot of trucks want to use this hub because of the costs and hub time. However, as other actors pay for using this hub, some trucks (with very high waiting times) choose to use the hub. However, the hub is probably not on the route between the origin and destination of most of these trucks. Thus, the total operational time of these trucks can become negative. Both the total gains of the trucks using the hub (table 6.7) and the estimated new revenues because of the operational time gain (table 6.8) should be taken into account for the estimated profit of trucking companies investing in a hub with extended opening hours. Table 6.9 shows these total profits of investing in a hub with extended opening hours for all scenarios.

Table 6.9: Estimated profit of trucking companies investing in a hub with extended opening hours

Scenario	Gain of trucks using the hub per day (€)	New revenues of operational time gain per day (€)	Total profit of the hub per day (€)	Total profit of the hub per year (€)
1	-€166 – €334	€1.000 – €1.500	€834 – €1.834	€304.410 – €669.410
2	-€452 – €48	€600 – €900	€148 – €948	€54.020 – €346.020
3	-€259 – €741	€2.400 – €3.600	€2.141 – €4.341	€781.465 – €1.584.465
4	-€903 – €97	€1.200 – €1.800	€297 – €1.897	€108.405 – €692.405
5	-€5.478 – €522	€3.600 – €5.400	-€1.878 – €5.922	-€685.470 – €2.161.530
6	-€8.554 – -€2.254	-€2.700 – -€1.800	-€11.254 – -€4.054	-€4.107.710 – -€1.479.710
5*	€3.522	€4.514	€8.036	€2.933.140
6*	€3.447	-€2.257	€1.190	€434.350

To give a clear overview, the daily profit of trucking companies investing in a hub with extended opening hours is also shown in figure 6.8 below. As can be seen in this figure and table 6.9, it is estimated that the profit of trucking companies investing in a chassis-exchange (scenarios 1 to 4) is around €150 to €4.300 per day and thus around €54.000 to €1.600.000 per year, depending on the hub location and capacity. It should be taken into account that these are the total profits of the hub investment. If for example, the investment in the hub is done by five different trucking companies, to ensure enough demand for the night distribution, the profit should be divided by five to get the profit per trucking company. However, this would mean that the CAPEX per trucking company are also divided by five. If for example, the total CAPEX of a chassis-exchange with 100 parking places would be €1.360.000 (because of buying 90 chassis of €4.000 and paying €10.000 per parking place for the ground and all security), the payback period of the hub investment would be 2 to 4.5 years in scenario 1 and 3.9 to 25.2 years in scenario 2. If the CAPEX of a chassis-exchange with a capacity of 200 trucks would be around €2.720.000 (because of buying 180 chassis and paying 200 times €10.000 per parking place), the payback period of the hub investment would be approximately 1.7 to 3.5 years in scenario 3 and 3.9 to 25.1 years in scenario 4. From these profits, it can be concluded that if trucking companies want to invest in a chassis-exchange, it would be better for them to invest in a chassis-exchange on the Maasvlakte (scenarios 1 and 3), as this leads to better profits than a chassis-exchange further away, like in the Botlek area (scenarios 2 and 4). If the capital of the trucking companies investing in a hub combined would be high enough and there is enough space on the Maasvlakte, a chassis-exchange with a capacity of 200 trucks is recommended, as its yearly profit is more than twice the profit of a chassis-exchange with 100 parking places.

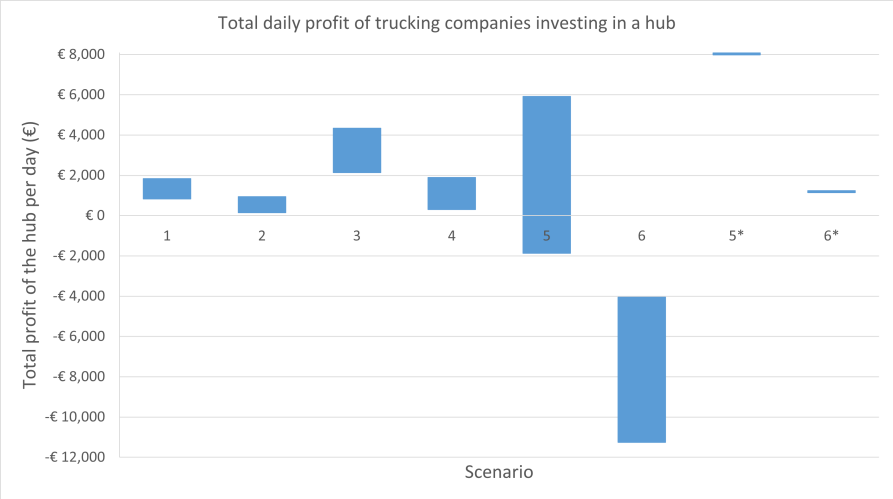


Figure 6.8: Total daily profit of trucking companies investing in a hub for every scenario

Furthermore, it is estimated that the profit of trucking companies investing in a container hub on the Maasvlakte, without other actors partly paying for the hub use (scenarios 5), is around - €1.900 to €6.000 per day and thus around - €685.000 to €2.200.000 per year. If the CAPEX of this container hub with a capacity of 300 trucks would be around €3.000.000 (due to buying 10 reach stackers of €200.000 and paying €1.000.000 for all the ground the containers are stored on and the reach stackers drive on) and the profit would be positive, the payback period of the hub investment could be 1.4 or many more years, depending on the profit. If the profit would be negative, the investment would not be earned back. As the maximum estimated profit of building a container hub is high, this could be a possibility. However, it should be considered that the profit can also be negative, depending on the exact costs and revenues of the hub. Furthermore, it should be taken into account that the combined demand of the trucking companies investing in the hub should be high enough to use the full hub capacity of 300 trucks. It can be seen that in scenario 6, the profit of trucking companies investing in a container hub without other actors paying for trucks using the hub, will be negative. Thus, this investment is not recommended. Moreover, the profits of trucking companies investing in a container hub while other actors partly pay for trucks using the hub (scenarios 5* and 6*) are estimated. As can be seen, the calculated profits are around €1.100 to €8.000 per day and thus around €430.000 to €2.900.000 per year, depending on the hub location. If the CAPEX of this container hub with a capacity of 300 trucks would be around €3.000.000, the payback period of the hub investment would be approximately 1 year in scenario 5* and 6.9 years in scenario 6*. However, it should be taken into account when comparing the profits of the container hubs to the profits of the chassis-exchanges, that other actors need to pay around €7.58 to €22.73 per container in scenario 5* and €15.15 to €30 per container in scenario 6* to guarantee the container hubs will be fully used and these gains are captured. As this is hard to ensure for every container, scenarios 5* and 6* are not very easy to accomplish for trucking companies. Thus, it would be easier and better for them to invest in a chassis-exchange.

Other actors

As stated in section 4.3, receivers profit from more reliable transport because of night-time transport, as containers avoiding the waiting times at terminals have a lower risk of arriving too late. Because of trucks using a hub with extended opening hours, receivers do not have to stay open during the night to facilitate night-time transport, which saves them a lot of costs. Moreover, terminals also profit from a better spread of truck arrivals as this leads to better use of their capacities. Less truck congestion in front of their gates leads to a better quality of their service and a higher attractiveness. Furthermore, more night-time container transport also leads to social gains of less road congestion and emissions. Because of this, the Ministry of Infrastructure and Water Management would also like to reduce the waiting times at container terminals in the port of Rotterdam. Additionally, as stated in section 4.3, the Port of Rotterdam would profit from less truck congestion in front of its terminals. Less truck congestion would lead to lower waiting times and fewer emissions in the port area, which causes the accessibility and attractiveness of the port to increase. Thus, the Port of Rotterdam is searching for ways to reduce the waiting times in front of its terminals. However, as stated in the interview (section G), the Port of Rotterdam will probably not invest in a solution if it would have to keep paying money (making a negative profit) over the years. Lastly, other actors than the ones stated above that want to make profits of exploiting a hub with extended opening hours could invest in a hub. This section discusses the possibilities of the costs and revenues

for when other actors than the trucking companies would invest in a hub with extended opening hours.

If receivers, terminals, the Ministry of Infrastructure and Water Management or the Port of Rotterdam would invest in a hub with extended opening hours, they would receive payments per truck from the trucking companies using the hub. As explained in section 4.3.3, the total hub costs for trucking companies using a chassis-exchange (scenarios 1 to 4) are estimated to be €15 to €20, of which around €14 belongs to the time it takes to use the hub. Thus, €1 to €6 belongs to ground and maintenance costs. If trucking companies use a hub that belongs to another actor, the payment per truck will be the total hub costs, subtracting the hub time costs, as can be seen in table 6.10. This is varied as the actual payment depends on if the actor owing the hub wants to build the hub to reduce waiting times at the terminals and wants to keep the extra costs low for trucking companies, or if the owner wants to make the most profit out of it. The hub costs per day also depend on the actor that invests in the hub. For example, if the Port of Rotterdam would build a hub on their own ground, they would not have to pay for ground costs. As it is unknown what these hub costs will exactly be, these are also varied between the possible ground and maintenance costs of €1 to €6 per truck. The total hub costs for trucking companies using a container hub (scenarios 5* and 6*) are estimated to be €30 to €50, of which around €28 belongs to the time it takes to use the hub. Thus, €2 to €22 belongs to ground, maintenance and reach stacker operator costs. However, as found in the sensitivity analyses in section 6.2.1, 300 trucks will only use the hub if the costs for trucking companies would be €20 or lower in scenario 5* and €10 or lower in scenario 6*. Thus, in scenarios 5* and 6*, other actors than the trucking companies would have to pay €8 per truck to the trucking companies in scenario 5* and €18 per truck in scenario 6*, so their hub time costs will not exceed €20 and €10, respectively. Furthermore, these other actors would have to pay €2 to €22 to the owner of the hub, depending on the hub costs and price. When calculating the profit of the actor investing in the hub, it is assumed that the actor does not want to make yearly net losses. Thus, this actor will set the prices of the hub for trucking companies to be the same or higher than the hub costs it experiences per truck.

Table 6.10: Estimated revenues, costs and profits when investing in a hub with extended opening hours

Scenario	Payment per truck visit (€)	Truck visits per day (#)	Hub costs per day (€)	Total profit per day (€)	Total profit per year (€)
1	€1 – €6	100	€100 – €600	€0 – €500	€0 – €182.500
2	€1 – €6	100	€100 – €600	€0 – €500	€0 – €182.500
3	€1 – €6	200	€200 – €1.200	€0 – €1.000	€0 – €365.000
4	€1 – €6	200	€200 – €1.200	€0 – €1.000	€0 – €365.000
5*	€2* – €22*	300	€600 – €6.600	€0 – €6.000	€0 – €2.190.000
6*	€2* – €22*	300	€600 – €6.600	€0 – €6.000	€0 – €2.190.000

In scenarios 1 to 4, if for example, the total CAPEX of a chassis-exchange with 100 parking places would be €1.360.000 and the CAPEX of a chassis-exchange with a capacity of 200 trucks would be around €2.720.000, the hub investment could be earned back after 7.5 or many more years, depending on the costs and price of the hub. If the actor investing in a chassis-exchange wants to make profit of owning the hub and there is enough space, a chassis-exchange with a capacity of 200 trucks is recommended, as its yearly profit is twice the profit of a chassis-exchange with 100 parking places. The location of the hub does not affect the profit of these actors, as enough trucks want to make use of the hub. However, as explained in section 6.2.1 and section 6.5.2, more trucks would want to use a hub located on the Maasvlakte as this would on average lead to more gains for them than a hub located in the Botlek area. To guarantee the full capacity of the hub will be used, it is recommend that this is considered when other actors would invest in a chassis-exchange.

Furthermore, in scenarios 5* and 6*, if the CAPEX of this container hub with a capacity of 300 trucks would be around €3.000.000 (due to buying 10 reach stackers and paying €1.000.000 for all the ground), the hub investment could be earned back after approximately 1.4 years or many more, depending on the costs and price of the hub. However, it should be taken into account when comparing the profits of the hubs, that other actors need to pay around €8 per truck in scenario 5* and €18 per truck in scenario 6* to the trucking companies to ensure the container hubs will be fully used and these gains are captured. Furthermore, these other actors would have to pay €2 to €22 to the owner of the hub, depending on the hub costs and price. If this would be done by the actor investing in the hub, no revenues would be made and the costs of the hub would lead to big yearly losses of the owner of the hub. Thus, in scenarios 5* and 6*, other actors than the actor investing in the hub have to pay these costs per container. As this is hard to ensure for every container, scenarios 5* and 6* are not easy to accomplish for trucking companies. Thus, it would be better for these actors to invest in a chassis-exchange.

7

Discussion, conclusion and recommendations

This chapter includes the discussion and conclusion of this research. Furthermore, recommendations for future research will be given. The discussion (section 7.1) reflects on the research and all its challenges. In the conclusion (section 7.2), the research questions of this thesis are answered. Section 7.3 gives recommendations for future research.

7.1. Discussion

During the research of this master thesis, various challenges have been encountered. Even though the results of this research are promising, some points of discussion should be taken into account. First of all, several challenges and opportunities of introducing a hub with extended opening hours are mentioned. Secondly, the simplifications of the research are analysed. Lastly, the limitations of the data used are discussed.

7.1.1. Challenges and opportunities of introducing a hub

As discussed in chapter 6, the waiting times at container terminals can be reduced by introducing a hub with extended opening hours. The results of this research are promising and indicate that a hub with extended opening hours can not only lead to gains of the system, but gains of trucking companies using the hub. However, the challenges and opportunities of a hub with extended opening hours should be considered closely when analysing the results of this research. This section first elaborates on the division of the waiting time gain. Secondly, the challenges and opportunities of horizontal collaboration are discussed. After that, the security of a hub is considered. Also, the long service times at terminals during the night and other challenges of night-time transport that were found in the literature review in chapter 2 are discussed. Lastly, the Downs-Thomson paradox is mentioned.

Division of waiting time gain

As stated in section 6.3, introducing a hub with extended opening hours could lead to total waiting time gains of 212 to 425 hours per day, which corresponds to around 3 to 6 million euros per year. These waiting time gains are not only perceived by the trucks changing to night-time terminal visits but by all trucks visiting the terminals during the hours the waiting times are reduced. At first sight, this seems unfair for the trucking companies actively switching (some of their trucks) to night-time container transport. However, this is an inevitable consequence of any solution to a problem with multiple players where some players should change their operations. Furthermore, trucking companies will only change to night-time container transport if this is more profitable for them. Thus, the waiting time gains are not the only positive effect of the introduction of a hub. For users of the hub, operational time gain could lead to the transportation of more containers per day and thus a higher profit for the trucking company.

However, if trucking companies state the operational time gain is not enough profit for them to use a hub with extended opening hours and do not want to be the ones changing to night-time container transport so that everyone will benefit, another division of the waiting time gain is possible. Actors like terminals, the Port of Rotterdam or the government that would want to mitigate truck congestion at terminals' gates, could introduce a gain division scheme. This signifies that the trucks switching to night-time container transport would benefit more from the waiting time gain than the trucks still visiting the terminals during the daytime. A possibility for doing this is giving the trucks that visit terminals at night a monetary incentive and/or charging a fee to trucks visiting the terminals during peak hours, like various programs at container terminals in ports have done (Bentolila et al., 2016). By doing this, trucking companies choosing for night-time transport would profit more from the waiting time gain that results from trucks visiting the terminals in off-peak hours.

Horizontal collaboration
Another opportunity that could lead to higher profits for trucking companies using a hub with extended opening hours is a horizontal collaboration between trucking companies. Switching some trucks to night-time container transport by using the hub is not as easy for all trucking companies. This is especially the case for smaller companies. One of the challenges that arise when considering night-time transport is that there should always be enough demand for container transport. A truck driver can not be switched from day to night regularly, due to a need for a regular sleeping pattern. Thus, every day there should be enough transport demand so that truck drivers can transport containers during their whole night and day shifts, which is not always the case at small trucking companies with low and/or varying container demands. Moreover, not all truck drivers want to work during the night. Thus, if a trucking company only has a few truck drivers, the chance is large that no driver wants to perform night-time transport. Because of these reasons, night-time container transport might not be an option for small trucking companies. For these companies to be able to use a hub, horizontal collaboration is needed.

Two small trucking companies could work together by both carrying out another leg of the transportation of one container. One trucking company could be appointed to perform the night-time transport between the terminals and the hub, as the other one would perform the container transport between the hub and the hinterland during the normal working hours. This horizontal collaboration could lead to more profit for both trucking companies. However, this would need a lot of trust in the other trucking company and comprehensive regulations on the use and insurance of shared chassis. Nonetheless, if trucking companies would put their efforts into making clear collaboration schemes, a hub could also lead to high opportunities for smaller companies.

Security of the hub
Another important aspect of implementing a hub with extended opening hours is providing robust security for the hub. The safety of all containers and chassis using this hub has to be guaranteed. Especially when containers with high values would want to make use of the hub. An example of securing a hub is adding a secure fence around the location, including a gate that can only be opened with a password, truck driver identification and license recognition. Furthermore, installing cameras at the hub could secure the location. If owners of the hub want to guarantee the complete security of the hub users, a guard could observe the facility. However, this would increase the costs of the hub.

Service times at night
An additional challenge that night-time container transport is facing, is the uncertain service times at container terminals during the night. At this moment, since not a lot of trucks arrive at the terminals during the night, fewer terminal operators are working at the terminals, which can lead to higher service times at night. Especially at the container terminals with less automated operations than the others. However, in an interview conducted with a container terminal (appendix G), they state that if more trucks would visit the terminal during the night, they would guarantee steady service times at night. In the past, they have already done tests with this, but at the moment too few trucks are arriving at night for them to continue doing this. Thus, if a hub with extended opening hours would ensure a steady number of truck arrivals during the night, terminals could cooperate by making sure more terminal operators are working at night and faster and more steady service times could be secured.

Challenges of night-time transport
As found in chapter 6, a hub with extended opening hours could lead to lower waiting times at container terminals and lower total operation times of transporting containers for trucks using the hub. These are consequences of better facilitating night-time container transport by enabling more terminal visits during the night, without receivers in the hinterland that have to be open outside of normal working hours. However, as discussed in the literature review in chapter 2, other reasons that complicate night-time container transport were found. This section discusses the various effects the implementation of a hub with extended opening hours has on actors. As stated by Holguín-Veras et al. (2005), reasons why night-time transport is sometimes difficult to implement are community complaints about noise at night, time-sensitive cargo and zoning restrictions. Furthermore, Bentolila et al. (2016) state that some countries ban trucks from the road network during the weekend and that there are legal labour restrictions of when and how much truck drivers should rest during night work. All these challenges should be taken into account when implementing a hub with extended opening hours. Thus, the hub should not be close to residential areas because of noise restrictions. Also, only containers that are allowed to drive at night can use the hub and if zones have restrictions during the night, no containers can be transported there during the night. Lastly, trucking companies have to comply with the regulations on when truck drivers should rest. Thus, two truck drivers might be needed to transport containers for the same amount of time that a truck driver transport containers during the day. The higher salaries of truck drivers are taken into account in the

discrete choice model in this research (section 5.4.2). It might be a challenge to find enough truck drivers that want to drive during the night, especially with the current shortage of employees in all sectors. This should be taken into account before investing in a hub with extended opening hours.

Pigou-Knight-Downs paradox
The last challenge included in the discussion is that if a hub with extended opening hours is introduced and the waiting times at container terminals are mitigated, visiting the terminals during peak hours would become more attractive. Thus, after shifting to more night-time container transport, trucking companies might choose to shift back to visiting the terminals during the daytime or to add more trucks transporting containers during the daytime. This concept can be compared with the Pigou-Knight-Downs paradox in road traffic. This paradox states that increasing the capacity of a road does not necessarily lead to less congestion. This occurs because extra cars might choose to use the enlarged road due to more capacity (Ding and Song, 2012). According to Ding and Song, this paradox can be resolved by adding a toll to the system. In this case, reducing the waiting times during peak hours could lead to extra trucks visiting the terminals during peak hours. As discussed in the *Division of waiting time gain* section, charging a fee to trucks visiting the terminals during peak hours could be an opportunity to provide more profit for trucks performing night-time container transport.

7.1.2. Simplifications of the research
As the period of this research was set to six months, it was necessary to make some simplifications of the methodology. This section elaborates on the simplifications made in the research methods. First, the fact that only the current waiting times at terminals are taken into account is discussed. Furthermore, the choice model of route assignment and the time of day choice are reviewed. Lastly, the truck level of modelling is discussed.

Current waiting times
As stated as a challenge above, improving the waiting times at terminals' gates could be compared to the Pigou-Knight-Downs paradox, as lower waiting times during peak hours lead to a higher attractiveness of visiting the terminals in these hours. If more trucks choose to perform night-time transport and after one month it is clear that this has reduced the waiting times during peak hours, more trucks might visit the terminals in the peak hours. Thus, the simulation model could be run again to analyse what would be the route choices of trucking companies with reduced waiting times. However, this could go on forever as newly found waiting times would again influence the route assignment of trucking companies. Thus, this research only uses the current waiting times as input for the route assignment to analyse the new choices of trucking companies and the effects these have on the waiting times at container terminals.

Choice model of route assignment
The choice model used in the route assignment of this research includes preference parameters for cost and time. It is probable that in the real route choice of trucking companies more parameters play a role, like the security of a hub and what truck drivers think of using a hub. However, no data on these or other attributes of hub preferences are known. Moreover, the costs and time are expected to be far more important for trucking companies than other attributes. Because of this, it is not believed that the simplification of the route choice model to only the cost and time parameters would lead to different results.

Furthermore, the choice model in the route assignment is formulated as a multinomial logit model (MNL), because of the good fit for this research. However, if alternatives of the choice model could overlap, it is better to formulate a mixed logit model, including another estimated parameter. The alternatives in this research are the direct route and the hub route alternative. Only for the orders from customer zones that are located in the same area as the hub, there is a possibility that a small part of the alternatives, which is the route towards this zone, might be overlapping. For these particular orders, the mixed logit model might have been a better fit. However, it is expected that this simplification of the choice model does not lead to significantly different results in hub preferences. Moreover, as the amount of trucks wanting to use a hub is always more than the capacity of a hub, a small change in hub preferences would not influence the results of this research, which are waiting time gains at container terminals.

Time of day choice
Another simplification of the methodology is the time of day choice of trucking companies. As no data is known on the time of day choice of trucks visiting the terminals, data on the current time of day arrivals at terminals is used for the time of day choice. For every terminal, the number of truck arrivals per hour is modelled as a distribution. For every truck order, a time of day gets drawn from the distribution belonging to the terminal of that order. Section 7.3 recommends future research on this topic.

Modelling at truck level
Lastly, all data available is built up at truck level. This signifies that no information is known about the content of these trucks. The trucks visiting the terminals and driving between the terminals and the hinterland could carry a full import container, a full export container, an empty container or no container at all. Trucks visiting the terminals could drop off a container and pick up another one, or only perform one of these operations. Because of this, the simulation is modelled at truck level. Thus, it does not matter what are the exact operations of the truck. Since all terminal visits include at least one (arriving and/or leaving) container and a hub with extended opening hours could be used for all types of containers (import, export or empty), a hub could be used for every terminal visit. Thus, this simplification is considered to be appropriate for this research.

7.1.3. Limitations of data used
In this research, several data sources are used for the simulation model. These include the data of counting points in front of all terminals, the origin-destination data from TomTom and the travel time data from the Distance Matrix API from Google Maps. All data sources have some limitations, which are discussed below.

Counting point data
As stated in section 5.1, the available counting point data that measures the number of arrivals and departures per hour for every terminal, only has complete data for the second week of January. The number of arrivals per hour for an average workday in this week is used for the input (trip generation) of this model. The number of departures per hour for an average workday in this week is used for the calibration of the terminal model. Thus, the results of this model simulate the waiting times of an average workday in the second week of January, instead of the actual average workday. If data from other weeks would become available in the future and would show that the data from the average workday in the second week of January is not similar to the data from the average workday of a whole year, new data should be used for input and calibration of this simulation model.

Origin-destination data
Furthermore, the origin-destination data that is used from TomTom also has limitations. To make the data anonymous, the first and last few minutes of the trip are deleted from the data. This results in the fact that the origin-destination data is not very accurate. If a truck stops its trip immediately after entering a new zone, the wrong ending zone might be saved. Same with the starting point, if a truck departs close to the border of a zone. Furthermore, the origin-destination data does not distinguish between passenger cars and freight trucks. Even though the hours with peaks of passenger cars were filtered out, the data still includes origin-destinations of passenger cars. Thus, the weight of the zones that passenger cars are driving to and from the terminals, are overestimated in the origin-destination data. However, both of these limitations do probably not affect the simulation model significantly, as the percentages of all origin-destination pairs are verified with experts and no unexpected values were found in the data.

Travel time data
As stated in section 5.4, the delays on the routes between the terminals and the hinterland during peak hours that were discovered using the Distance Matrix API from Google Maps were lower than was expected by experts at the Port of Rotterdam. Reasons for this are the fact that Google Maps does not distinguish passenger cars and freight trucks and the fact that delays are still lower than before the Covid pandemic. Thus, it could be possible that if higher delays during peak hours were used as input for the route assignment, even more trucks would want to use the hub with extended opening hours. However, as the capacities of the hub are reached in every scenario, this is not expected to influence the results of this research.

7.2. Conclusion
After reflecting the research in the discussion, this section concludes the research and answers the main research question. This research focuses on the (increasing) problem of truck congestion at container terminals during peak hours. Since this research is a case study for the port of Rotterdam, the truck congestion at container terminals in the port of Rotterdam is researched. This truck congestion is leading to large waiting times, high costs for trucking companies, frustrated truck drivers and truck drivers exceeding their legal working hours. Besides this it leads to containers arriving too late at the hinterland, a lower attractiveness of the port of Rotterdam, high emissions of idling trucks and lastly, congestion on the infrastructure surrounding the port. The literature review (chapter 2) focused on reducing truck congestion at container terminals. Three possible solutions for this problem that were analysed were (1) increasing the terminal capacity, (2) decreasing the modal split of trucks and (3) spreading the truck arrivals to off-peak hours. The last solution can be carried out in three ways that is (1) restricting the truck arrivals, (2) encouraging off-peak transport

and (3) better facilitating off-peak transport. This research focuses on the last solution, as the main challenge of off-peak transport in the port of Rotterdam is that most receivers of containers in the hinterland are only open during working hours. Introducing a hub with extended opening hours, where containers can be transported between the hub and the terminals at night, could help facilitate night-time container transport. However, investing in such a hub is rather costly, and actors will only do this if they are sure that the hub will be used. As not a lot of research is done on this concept, especially on when actors in the container transport system would want to use such a hub, this research focuses on this challenge. The research objective is to evaluate the actors and their (inter)actions in the container transport system and to analyse the effects of designing night-time container transport using a hub with extended opening hours to mitigate truck congestion at terminals' gates in several scenarios. The main research question of this master thesis is the following:

How can truck congestion at terminals' gates be mitigated designing night-time container transport between port and hinterland using a hub with extended opening hours?

As stated in the methodology in chapter 3, agent-based modelling is used to set up the sub-questions of this research. The following sub-questions are formulated to be able to answer the main research question:

1. What actors can make decisions about night-time container transport?
2. What influences each actor's decision that can lead to night-time container transport?
3. How can these actors' decisions and their interactions be modelled?
4. What are the possible waiting time gains at terminals' gates from facilitating night-time container transport between port and hinterland using a hub with extended opening hours in several scenarios?

7.2.1. Analysis of actors, their decisions and interactions

Using literature research and semi-structured interviews with trucking companies, receivers, freight forwarders, a terminal, the Port of Rotterdam and the Ministry of Infrastructure and Water Management, sub-questions 1 and 2 are answered in chapter 4. It was found that trucking companies are the actors that decide whether to drive directly between the terminals and the hinterland or to use a hub. However, the actions and decisions of other actors influence the final decision of trucking companies. Using information from the interviews and theory on agent-based modelling, sub-question 3 is answered in chapter 5. A simulation model was created in the simulation program Anylogic, which can be used for combining agent-based modelling with discrete event simulation. The four-step transportation forecasting model is used to set up this simulation model. Aspects of the modelling framework that were used to calculate the current waiting times at terminals' gates were trip generation and the terminal model, which was created using queueing theory. In the hub scenarios, the other aspects of the modelling framework, which are trip distribution, route assignment and the agent interaction model, are used to calculate the new waiting times after introducing a hub with extended opening hours. The choice of trucking companies to drive directly between the terminals and the hinterland or to use a hub with extended opening hours is made using a discrete choice model.

7.2.2. Waiting time gains

Using the simulation model created in Anylogic, sub-question 4 is answered in chapter 6. The following scenarios were taken into account in the simulation model:

Table 7.1: Scenarios of adding a hub with extended opening hours to the model

Scenario	Type of hub	Turnaround time (minutes)	Total costs per truck (euros)	Capacity (# of trucks)	Location
1	Chassis-exchange	10	€15 - €20	100	Maasvlakte
2	Chassis-exchange	10	€15 - €20	100	Botlek
3	Chassis-exchange	10	€15 - €20	200	Maasvlakte
4	Chassis-exchange	10	€15 - €20	200	Botlek
5	Container hub	20	€30 - €50	300	Maasvlakte
6	Container hub	20	€30 - €50	300	Botlek

Chassis-exchange

Chapter 6 analyses the waiting time gains in all scenarios. Scenarios 1 to 4 have evaluated the introduction of a chassis-exchange to the container transport system. Both the Maasvlakte and the Botlek are used as locations for a possible chassis-exchange, and capacities of 100 and 200 trucks are compared. In all scenarios and with all possible hub costs,

more trucks want to use the hub than its capacity. The total waiting time gains are pretty high, with total monetary gains of around 3 to 6 million euros per year. The total waiting time gain can be seen as the system gain of this solution, as all trucks visiting the container terminals will benefit from some trucks using a hub with extended opening hours. However, the trucking companies using the hub also benefit from the operational time gain of all trucks waiting at terminals' gates, driving between the terminals and the hinterland and visiting a hub. Because of avoiding long waiting times at terminals' gates during peak hours, these trucking companies could transport more containers per day, as explained in section 6.4. Thus, introducing a chassis-exchange is recommended for facilitating night-time container transport to mitigate truck congestion at terminals' gates.

When comparing the Maasvlakte and the Botlek area as locations to place a chassis-exchange, it can be seen that both the waiting time gains, as well as the operational time gains are higher for a chassis-exchange located on the Maasvlakte than in the Botlek area. Furthermore, more containers want to use the chassis-exchange when it is located on the Maasvlakte because this is less of a detour than the Botlek area for many containers. Thus, it can be concluded that when searching for the highest total waiting time reduction, and when searching for the largest operational time gains, it is recommended to build a chassis-exchange on the Maasvlakte. As expected, a chassis-exchange with a capacity of 200 trucks leads to a waiting time gain of almost twice the gain of a hub with a capacity of 100 trucks. Whether a chassis-exchange with a capacity of 100 or 200 trucks should be implemented depends on the corresponding capital expenditures (CAPEX) and the maximum amount investors are willing to pay for building a chassis-exchange. Furthermore, it could be possible to introduce two or more chassis-exchanges with 100 trucks or less capacity. Especially if a few trucking companies decide to build private chassis-exchanges, that only they can use, they might choose to build a hub with a smaller capacity, depending on the number of containers they transport. Section 7.2.3 further discusses the possibilities of investment by various actors.

Container hub

In scenarios 5 and 6, it was found that if other actors do not pay for using the hub with extended opening hours, not enough trucking companies would want to use a container hub so the capacity would be fully used. In the case of a container hub on the Maasvlakte, depending on the total costs per night, other actors would have to pay €7.58 to €22.73 to trucking companies per container that use the hub, for 300 trucks to use the hub, which is the capacity of this container hub. In the case of a container hub in the Botlek area, other actors would have to pay €15.15 to €30.30 to trucking companies per container that use the hub for 300 trucks to use the hub. Because the waiting time gains corresponding with hubs that have capacities below 300 are already analysed in scenarios 1 to 4, scenarios 5 and 6 are analysed assuming other actors would pay those amounts to trucking companies, and the hub would be fully used. Even though it is not presumable that other actors pay that amount per container for using the hub, it is possible. For example, if the content of the containers is precious and the container must arrive at the receiver on time. However, the waiting time gains for scenarios 5 and 6 are not much higher than those in scenarios 3 and 4, which introduce a chassis-exchange used by 200 trucks, with no extra payment of other actors per container. Thus, it can be concluded that a container hub that has a turnaround time of 20 minutes and costs per night of €30 to €50 is a less attractive solution for facilitating night-time container transport. If the costs of using a container hub would be reduced in the future, new research could lead to different results. Furthermore, it is found that possible profits could be made when trucking companies invest in a container hub themselves. Section 7.2.3 elaborates on this.

7.2.3. Investing in a hub

As stated in section 6.5, various actors could invest in a hub with extended opening hours. The CAPEX of building a chassis-exchange are estimated to be lower than the CAPEX of building a container hub. The reason for this is that no expensive reach stackers are needed. However, new chassis need to be bought to use the full capacity of the chassis-exchanges. This research uses an estimated CAPEX of around €1.360.000 for a chassis-exchange with 100 parking places, €2.720.000 for a chassis-exchange with 200 parking places and €3.000.000 for a container hub with the capacity of 300 trucks. Actors should have enough capital to pay for these capital expenditures. If this is not the case, various actors could combine their capital to invest in a hub with extended opening hours. For example, multiple trucking companies could invest in a hub together. If trucking companies would profit from owning this hub, they could send their trucks to use it even though it is not more profitable for every truck, as was the case for a container hub. If no other actors have to pay for trucks using the hub, it was found that trucking companies could profit most from investing in a container hub located on the Maasvlakte, depending on the exact hub costs and revenues. However, the profit of investing in this container hub could also be negative. Further research on the exact hub costs and extra revenues of transporting more containers should be done to analyse the estimated profit precisely. A solution with less uncertainty is investing in a chassis-exchange on the Maasvlakte. The estimated profits of trucking companies investing in this hub

are always positive and higher than a chassis-exchange in the Botlek area. Suppose the trucking companies investing in this hub would have enough capital. In that case, a chassis-exchange with 200 parking places is recommended over a chassis-exchange with 100 parking places, as the yearly profit is more twice as high. If trucking companies would invest in a chassis-exchange on the Maasvlakte with a capacity of 200 trucks, the payback period of their investment would be approximately 1.7 to 3.5 years. If other actors like receivers, terminals, the Port of Rotterdam or the Ministry of Infrastructure and Water Management invested in a chassis-exchange, the profit would depend on the costs of the hub and the price the owners of the hub ask for trucking companies using their hub. The latter depends on if the goal hub owner is to participate in facilitating night-time transport to reduce waiting times at the terminals or to make as much profit as possible. Investing in a container hub is not recommended for other actors than trucking companies. As not enough trucking companies would want to use this hub, other actors need to pay for trucks using this hub, which is not easy to assure for every container.

One of the main reasons why currently not many actors are thinking about investing in a hub with extended opening hours is that it was unknown when actors would use such a hub and whether the investment would be profitable for them. This research could be beneficial for the discussion and actual implementation of a hub with extended opening hours. This research aims to be another incentive for actors to move towards the implementation of a hub with extended opening hours. This research is mainly done using Anylogic as a simulation model because of its face validity. The model can be easily shown and explained to actors in the system. Presentations are planned for the end of March to discuss the findings of this research with various people at the Port of Rotterdam. Section 7.2.4 elaborates on the takeaways of this research for the Port of Rotterdam.

7.2.4. Takeaways for the Port of Rotterdam

This section discusses the takeaways of this research for the Port of Rotterdam. The subject of this research was chosen to combine the literature gap found in the literature review on existing research in chapter 2, with the wish of the Port of Rotterdam to investigate new solutions to reduce waiting times at their terminals. The Port of Rotterdam had expressed their wish for a data-based research to analyse new solutions to reduce the truck congestion at the terminals' gates. Some assumptions and estimations are made in the exact results of this research. However, recommendations for investing in a chassis-exchange over a container hub and a hub located on the Maasvlakte over a hub located in the Botlek area are useful knowledge for the Port of Rotterdam. Furthermore, the research confirms that implementing a hub with extended opening hours would lead to more night-time container transport and lower waiting times at terminals, and profits for the hub investment. The Port of Rotterdam could use the findings of this research to either invest in a hub with extended opening hours itself or convince other actors in the system to invest in a hub with extended opening hours. The simulation model created in this research could be used to substantiate this solution. A manual for the simulation model is made and given to the Port of Rotterdam. This model could also be used for future research to analyse the effects of other solutions on truck congestion at terminal gates. Recommendations for future use of the simulation model are made in section 7.3.

7.3. Recommendations

This section includes recommendations following this research. First, recommendations for practice are discussed. These recommendations explain what steps need to be taken to put the findings of this research into practice. Next, the recommendations for future research are mentioned.

7.3.1. Recommendations for practice

This section discusses the recommendations that are needed for the next steps to be taken after this research. To use the findings of this research, research is recommended on where to place a hub with extended opening hours exactly. In this research, the Maasvlakte and the Botlek area are taken into account, as these were zones with a lot of truck demand. The Port of Rotterdam had stated to be interested in knowing the results of introducing a hub in these locations. However, when finding an exact location for a hub, many factors have to be taken into account. For example, the distance of the hub to surrounding neighbourhoods, as noises during the night can not bother sleeping people close to the hub. All important factors should be taken into account for the decision of the exact location a hub with extended opening hours can be introduced. Furthermore, actors that possibly want to invest in a hub with extended opening hours should make a detailed cost-benefit analysis for investing in such a hub. All actual capital expenditures (CAPEX) should be taken into account, and the benefits that will be received after building the hub. This could lead to the final decision of hub characteristics, like the capacity and security of the hub.

Moreover, as mentioned, this research uses the number of truck arrivals and departures at terminals from the second week of January for input and calibration of the model, as this was the only complete data. Whenever the complete counting point data becomes available, this data should be compared to the data of the second week of January. If the data is significantly different, new input should be given to the simulation model built in this research. After re-calibration of the model, the new results should be analysed. Furthermore, as the route choice model formulated in this research is simplified due to lack of data and time, future research should be done on a thorough route choice model that includes more attributes apart from cost and time. Moreover, a mixed logit model should be considered and compared to the current multinomial logit model.

7.3.2. Recommendations for future research

Lastly, this section includes recommendations for future research. First of all, research on a time of day choice model is recommended. The time of day choice of trucking companies that have to visit the terminals should be investigated. This could further analyse trucking companies' reasoning and the choice to perform night-time container transport by using a hub with extended opening hours or to keep performing daytime transport. Furthermore, research into other policies that could also mitigate the truck congestion at container terminals is recommended. For example, the benefits of introducing a peak hour fee for visiting the terminals in the port of Rotterdam should be researched. Combining solutions like a hub with extended opening hours and a fee for trucks visiting the terminals in peak hours could lead to more waiting time gains than one solution on its own.

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A

Research questions

Figure A.1 is based on figure 3.1 that shows the steps of setting up an agent-based model. After following the steps in the figure below, the main research question can be answered. The numbers on the left represent the sub-questions of this research that belong to that step of the figure. The research questions of this thesis are:

How can truck congestion at terminals' gates be mitigated designing night-time container transport between port and hinterland using a hub with extended opening hours?

1. What actors can make decisions about night-time container transport?
2. What influences each actor's decision that can lead to night-time container transport?
3. How can these actors' decisions and their interactions be modelled?
4. What are the possible waiting time gains at terminals' gates from facilitating night-time container transport between port and hinterland using a hub with extended opening hours in several scenarios?

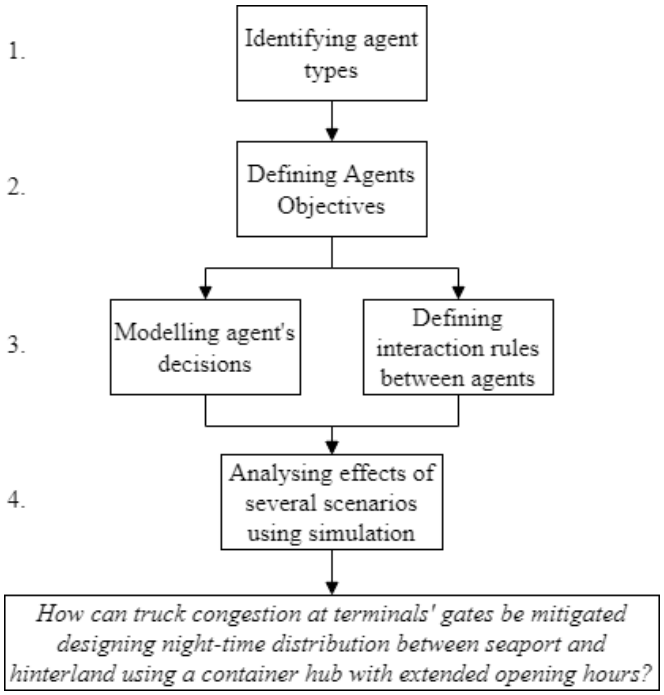

Figure A.1: Steps for answering main research question

B

Results scenarios

This appendix includes all results of the simulation model for the six scenarios where a hub with extended opening hours is added to the system. Every simulation run simulates one day (24 hours) of truck transport between the terminals in the port of Rotterdam and the hinterland. For every result, 10 simulation runs are executed to avoid simulation bias, with the use of 10 different seeds. After running these simulations, the results are averaged over all 10 simulation runs.

B.1. Scenario 1

Scenario 1 simulated the container transport system after the introduction of a chassis-exchange on the Maasvlakte with a capacity of 100 containers. The turnaround time at the hub is 10 minutes and the total costs per night for using the hub is varied between €15,00 and €20,00. The results of scenario 1 can be found in table B.1 and figure B.1.

Terminal	Hub preferences (#)	Hub users (#)	Total waiting time (hours)
A	0 - 26	2	61
B	21 - 389	31	138
C	160 - 402	31	247
D	399 - 459	35	405
Total	580 - 1276	100	851

Table B.1: Results of scenario 1

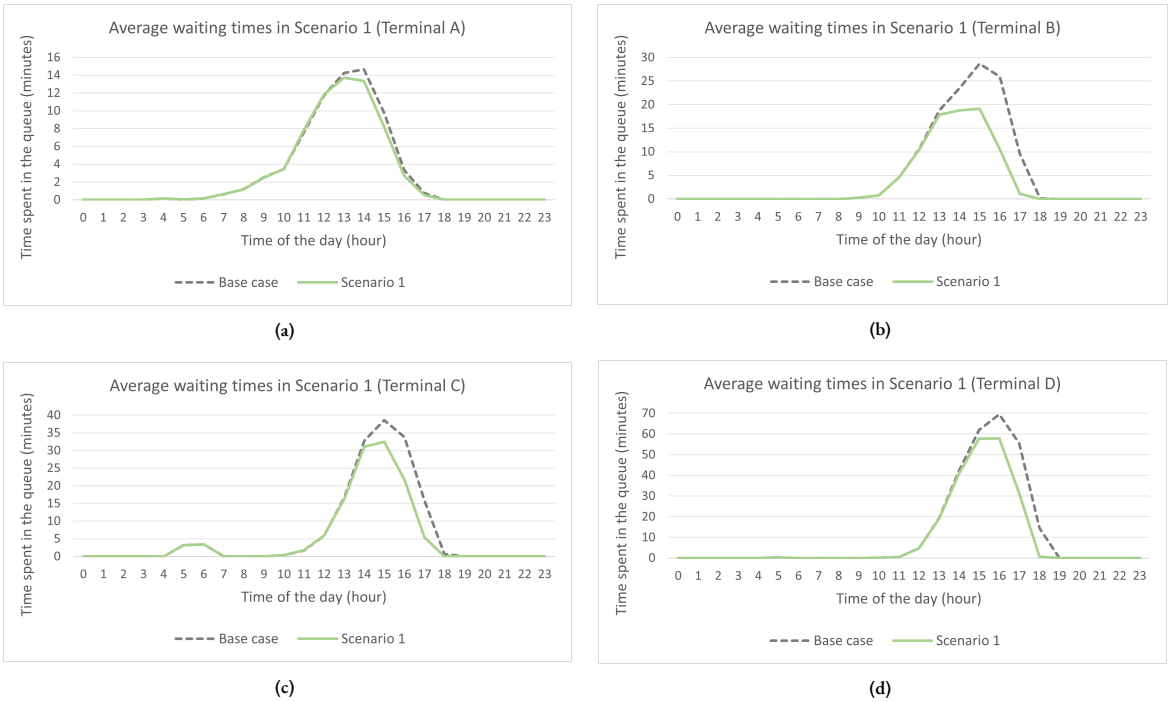

Figure B.1: Averaged simulated waiting times per time of the day for every terminal in scenario 1

As can be seen in table B.1, the total waiting time per terminal is not influenced by the price of the chassis-exchange, as the capacity of the hub is always fully used. Thus, there is no need for other actors to (partly) pay for trucking companies using the chassis-exchange. The total operational time gain of the trucks switching from direct route to hub route for waiting at the terminal's gates, driving from the terminal to the customers and visiting the hub in scenario 1 is 15 hours per day.

B.2. Scenario 2

Scenario 2 simulated the container transport system after the introduction of a chassis-exchange in the Botlek area with a capacity of 100 containers. The turnaround time at the hub is 10 minutes and the total costs per night for using the hub is varied between €15,00 and €20,00. The results of scenario 2 can be found in table B.2.

Terminal	Hub preferences (#)	Hub users (#)	Total waiting time (hours)
A	0 - 5	0	65
B	2 - 111	19	173
C	20 - 205	32	250
D	203 - 304	49	390
Total	225 - 625	100	878

Table B.2: Results of scenario 2

Also in this scenario it can be seen that the total waiting time per terminal is not influenced by the price of the chassis-exchange, as the capacity of the hub is always fully used. The total operational time gain of the trucks switching from direct route to hub route for waiting at the terminal's gates, driving from the terminal to the customers and visiting the hub in scenario 2 is 10 hours per day. The waiting times of all terminals, compared with the base case, are given in figure B.2.

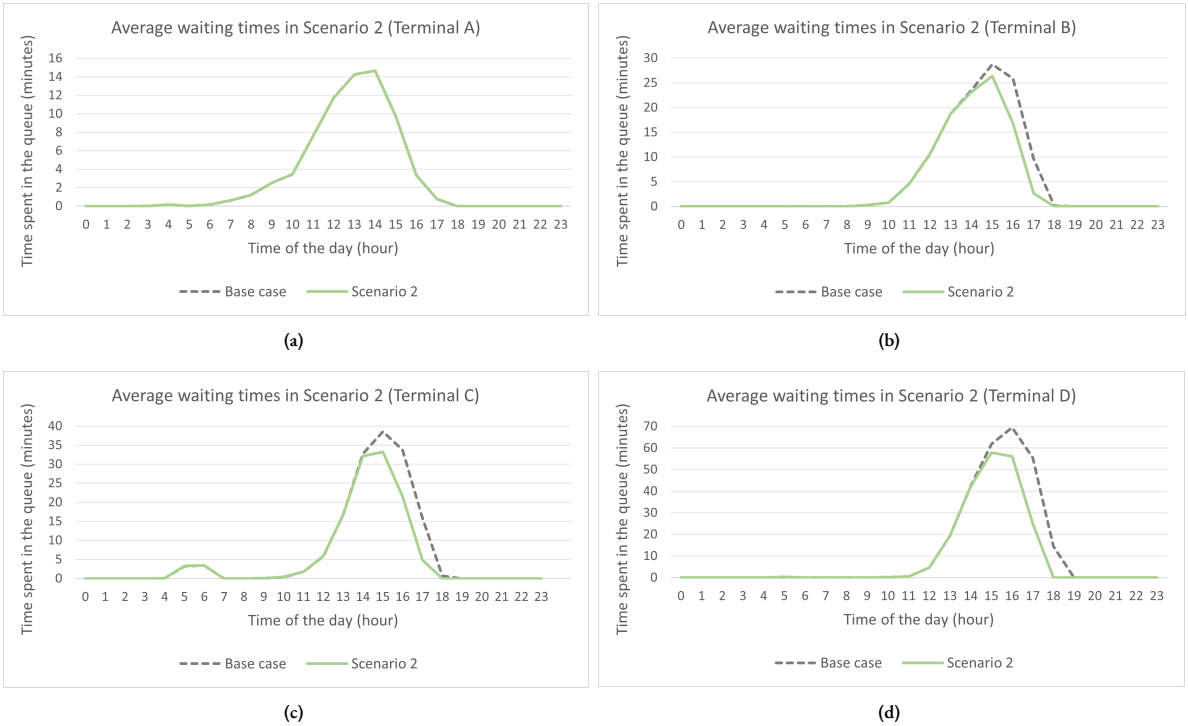

Figure B.2: Averaged simulated waiting times per time of the day for every terminal in scenario 2

B.3. Scenario 3

Scenario 3 simulated the container transport system after the introduction of a chassis-exchange on the Maasvlakte with a capacity of 200 containers. The turnaround time at the hub is 10 minutes and the price per night for using the hub is

varied between €15,00 and €20,00. The results of scenario 3 can be found in table B.3.

Terminal	Hub preferences (#)	Hub users (#)	Total waiting time (hours)
A	0 - 26	5	57 hours
B	21 - 389	62	95 hours
C	160 - 402	62	194 hours
D	399 - 459	71	323 hours
Total	580 - 1276	200	670 hours

Table B.3: Results of scenario 3

The total operational time gain of the trucks switching from direct route to hub route for waiting at the terminal's gates, driving from the terminal to the customers and visiting the hub in scenario 3 is 33 hours per day. The waiting times of all terminals, compared with the base case, are given in figure B.3.

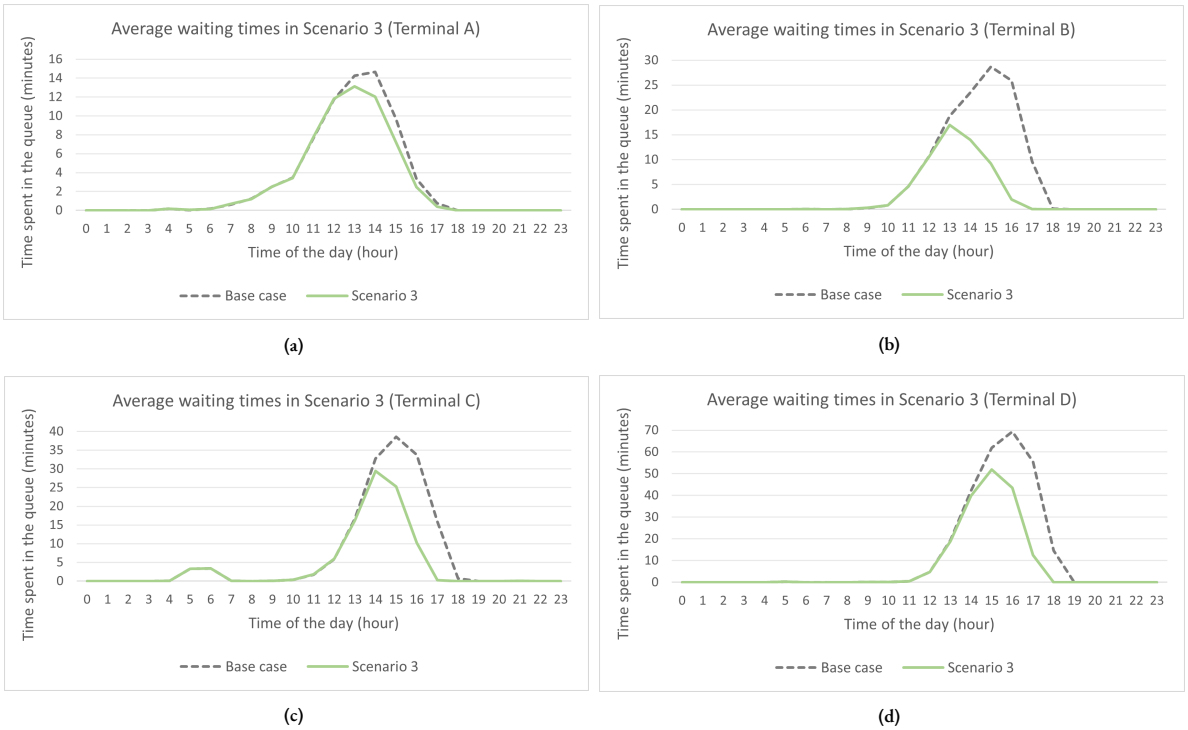

Figure B.3: Averaged simulated waiting times per time of the day for every terminal in scenario 3

B.4. Scenario 4

Scenario 4 simulated the container transport system after the introduction of a chassis-exchange in the Botlek area with a capacity of 200 containers. The turnaround time at the hub is 10 minutes and the price per night for using the hub is varied between €15,00 and €20,00. The results of scenario 4 can be found in table B.4.

Terminal	Hub preferences (#)	Hub users (#)	Total waiting time (hours)
A	0 - 5	1	62 hours
B	2 - 111	37	152 hours
C	20 - 205	65	201 hours
D	203 - 304	98	302 hours
Total	225 - 625	200	717 hours

Table B.4: Results of scenario 4

The total operational time gain of the trucks switching from direct route to hub route for waiting at the terminal's gates, driving from the terminal to the customers and visiting the hub in scenario 4 is 20 hours per day. The waiting times of all terminals, compared with the base case, are given in figure B.4.

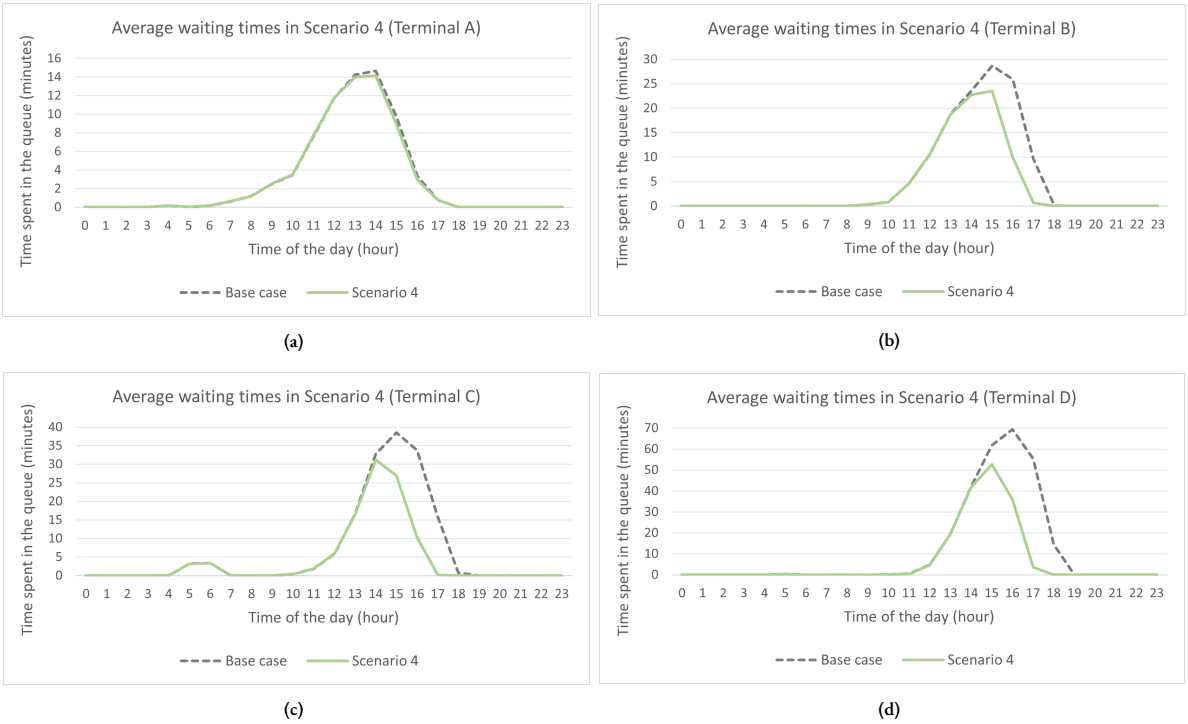

Figure B.4: Averaged simulated waiting times per time of the day for every terminal in scenario 4

B.5. Scenario 5

Scenario 5 simulated the container transport system after the introduction of a container hub on the Maasvlakte with a capacity of 300 containers. The turnaround time at the hub is 20 minutes and the price per night for using the hub is varied between €30,00 and €50,00. As discussed in section 6.2.1, scenarios 5 and 6 are run with varying amounts that other actors pay for trucking companies to use the container hub to ensure the full capacity of the container hub is used. Figure B.5 shows the number of trucks wanting to use the container hub (also called the *hub preferences*) per amount other actors pay for using the hub, if the price of using the container hub would be €50, which is the maximum estimated price of a container hub.

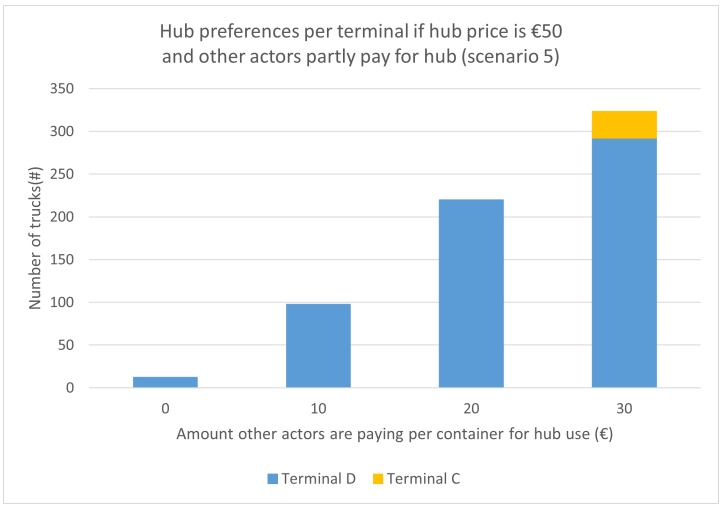

Figure B.5: Hub preferences per terminal if hub price is €50 and receivers partly pay for using the hub (scenario 5)

In figure B.5 it can be seen that if trucking companies would have to pay the whole €50 for using the hub, zero trucking companies would want to make use of the hub. The model has been run for the hypothetical case that other actors would pay 0, 10, 20 and 30 euros to the trucking companies for using the hub. This could for example be paid by receivers of the containers. The reason for them to do this would be that when trucking companies would use a hub with extended opening hours in the transportation of the container for the receiver, the chance that this container arrives at the location of the receiver too late becomes much smaller than in the current situation. When receivers would pay €30 to trucking companies for using the hub, more than 300 trucking companies would use the hub, which is the capacity of the container hub in this scenario. It is not very presumable that a lot of receivers would pay up to €30 for trucking companies for using the hub, but it is still possible. For example, if the content of the containers would be valuable and if it is very important that it arrives on time. As the waiting times for 100 and 200 hub users of a hub on the Maasvlakte are already calculated in scenarios 1 and 3, the results for a hub with 300 hub users will be evaluated in this scenario. Thus, the hub costs for trucking companies are set to €20 in scenario 5. Table B.5 shows the hub preferences without other actors paying for the hub, the number of hub users (with the payment of other actors) and the corresponding waiting times per terminal.

Terminal	Hub preferences (#)	Hub users (#)	Total waiting time (hours)
A	0 - 0	0	65 hours
B	0 - 0	0	205 hours
C	0 - 31	28	266 hours
D	12 - 292	272	216 hours
Total	12 - 323*	300	752 hours

Table B.5: Results of scenario 5 if receivers would pay €0 - €30

The total operational time gain of the trucks switching from direct route to hub route for waiting at the terminal's gates, driving from the terminal to the customers and visiting the hub in scenario 5 is 54 hours per day. The waiting times of all terminals, compared with the base case, are given in figure B.6.

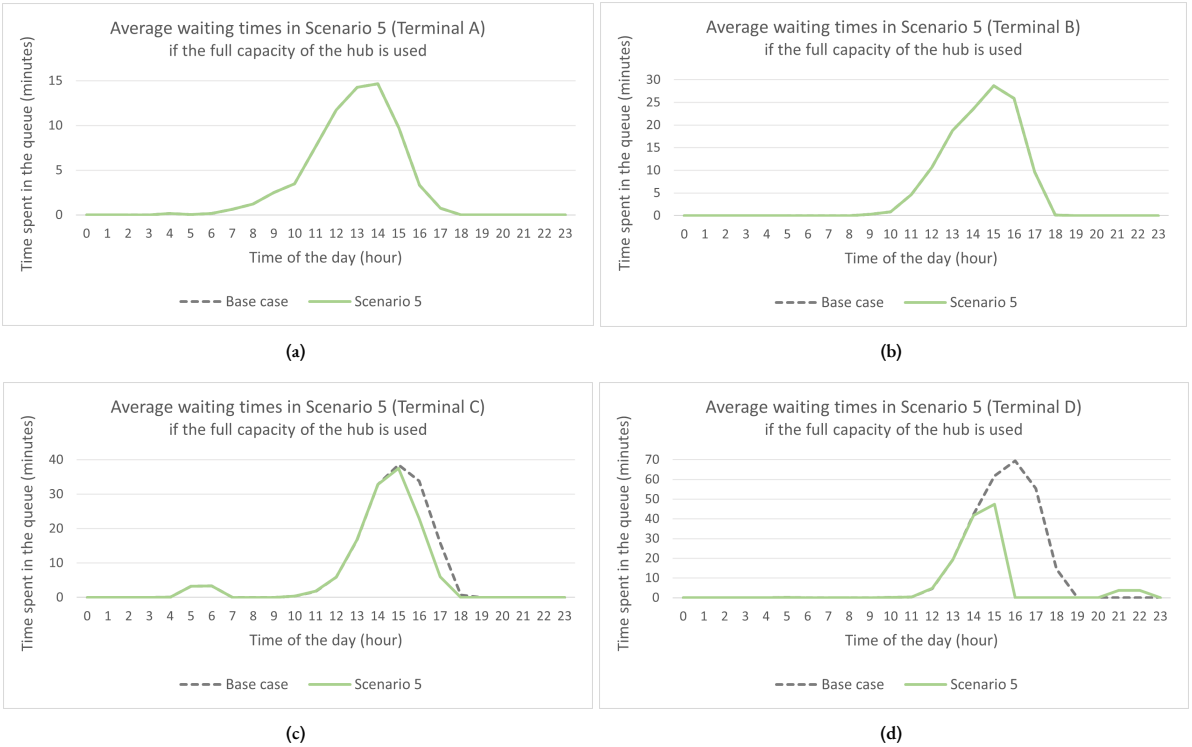

Figure B.6: Averaged simulated waiting times per time of the day for every terminal in scenario 5 if hub costs for trucking companies are €20

B.6. Scenario 6

Scenario 6 simulated the container transport system after the introduction of a container hub in the Botlek area with a capacity of 300 containers. The turnaround time at the hub is 20 minutes and the price per night for using the hub is varied between €30,00 and €50,00. Figure B.7 shows the number of trucks wanting to use the container hub (also called the *hub preferences*) per amount other actors pay for using the hub, if the price of using the container hub would be €50, which is the maximum estimated price of a container hub.

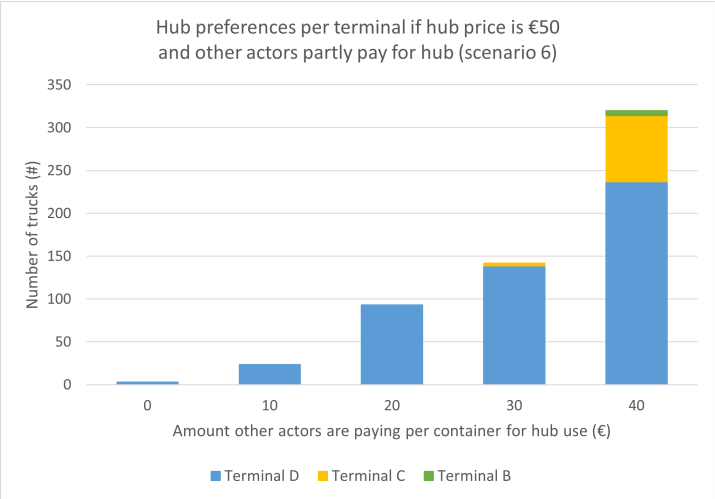

Figure B.7: Hub preferences per terminal if hub price is €50 and receivers partly pay for using the hub (scenario 6)

In figure B.7 it can be seen that if trucking companies would have to pay the whole €50 for using the hub, zero trucking companies would want to make use of the hub. The model has been run for the hypothetical case that other actors would pay 0, 10, 20, 30 and 40 euros to the trucking companies for using the hub. This could for example be paid by receivers of the containers. The reason for them to do this would be that when trucking companies would use a hub with extended opening hours in the transportation of the container for the receiver, the chance that this container arrives at the location of the receiver too late becomes much smaller than in the current situation. When receivers would pay €40 to trucking companies for using the hub, more than 300 trucking companies would use the hub, which is the capacity of the container hub in this scenario. Again, it is not very presumable that a lot of receivers would pay up to €40 for trucking companies for using the hub, but it is still possible. As the waiting times for 100 and 200 hub users of a hub in the Botlek area are already calculated in scenarios 2 and 4, the results for a hub with 300 hub users will be evaluated below. Thus, the hub costs for trucking companies are set to €10 in scenario 6. Table B.6 shows the hub preferences without other actors paying for the hub, the number of hub users (with the payment of other actors) and the corresponding waiting times per terminal.

Terminal	Hub preferences (#)	Hub users (#)	Total waiting time (hours)
A	0 - 0	0	65 hours
B	0 - 6	5	195 hours
C	0 - 78	72	207 hours
D	3 - 237	220	198 hours
Total	3 - 320*	300	665 hours

Table B.6: Results of scenario 6 if receivers would pay €0 - €40

The total operational time gain of the trucks switching from direct route to hub route for waiting at the terminal's gates, driving from the terminal to the customers and visiting the hub in scenario 6 is 29 hours per day. The waiting times of all terminals, compared with the base case, are given in figure B.8.

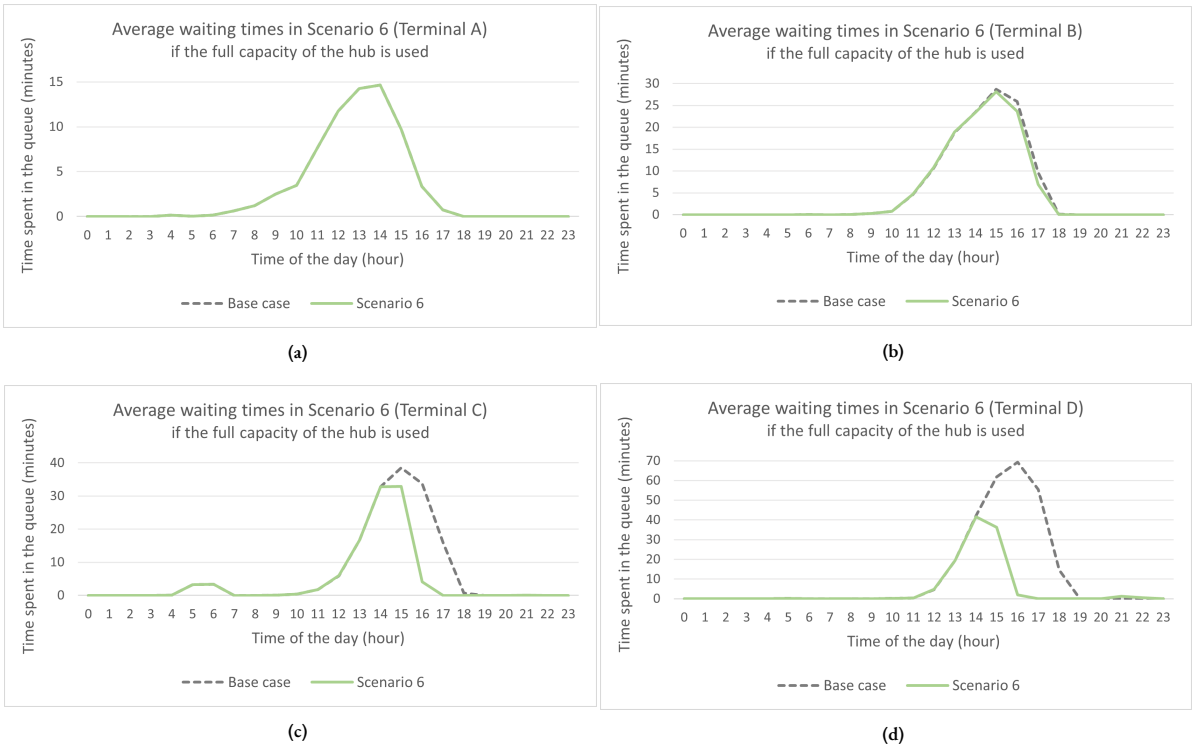

Figure B.8: Averaged simulated waiting times per time of the day for every terminal in scenario 6 if hub costs for trucking companies are €10

C

Agent interaction model

Figure C.1 shows a flow diagram of all decisions being made in the system. It starts whenever a shipper want to order container transport coming from or going to one of the container terminals in the port of Rotterdam. The shipper makes the decision to use a freight forwarder to arrange this transport, or to do it themselves. The next step, which is executed either by the shipper or the freight forwarder, is to check with a trucking company, also called a *carrier*, whether they are available at that time. If the shipper/freight forwarder has agreements with several carriers, they will probably first check the availability of the trucking company with the lowest price for container transport. The trucking company will check if they have available trucks and truck drivers for that time and either accept or deny the order of container transport. In the scenario were a hub is present, the shipper should decide on wanting to pay the trucking company extra or not for using this hub (depending on the chance that a container arrives at their facility too late). If it is very important for the shipper that the container arrives on time, they might consider paying extra for reducing this chance. With this knowledge, the trucking company will calculate all costs and time for all possible legs of transport (at night and during the day). The exact choice model of the trucking companies is discussed in section 5.4. After having decided on this, the origins and destination of the container transport legs are being send to the truck drivers. The truck drivers will drive between terminals, clients in the hinterland, empty depots and potential hubs. At the terminals, trucks have to stand in the queue until the crane is available of the gate that they have to pick up or deliver a container. If the crane is available, the truck will be served and leave the terminal. At clients, empty depots and hubs, an average turnaround time is assumed.

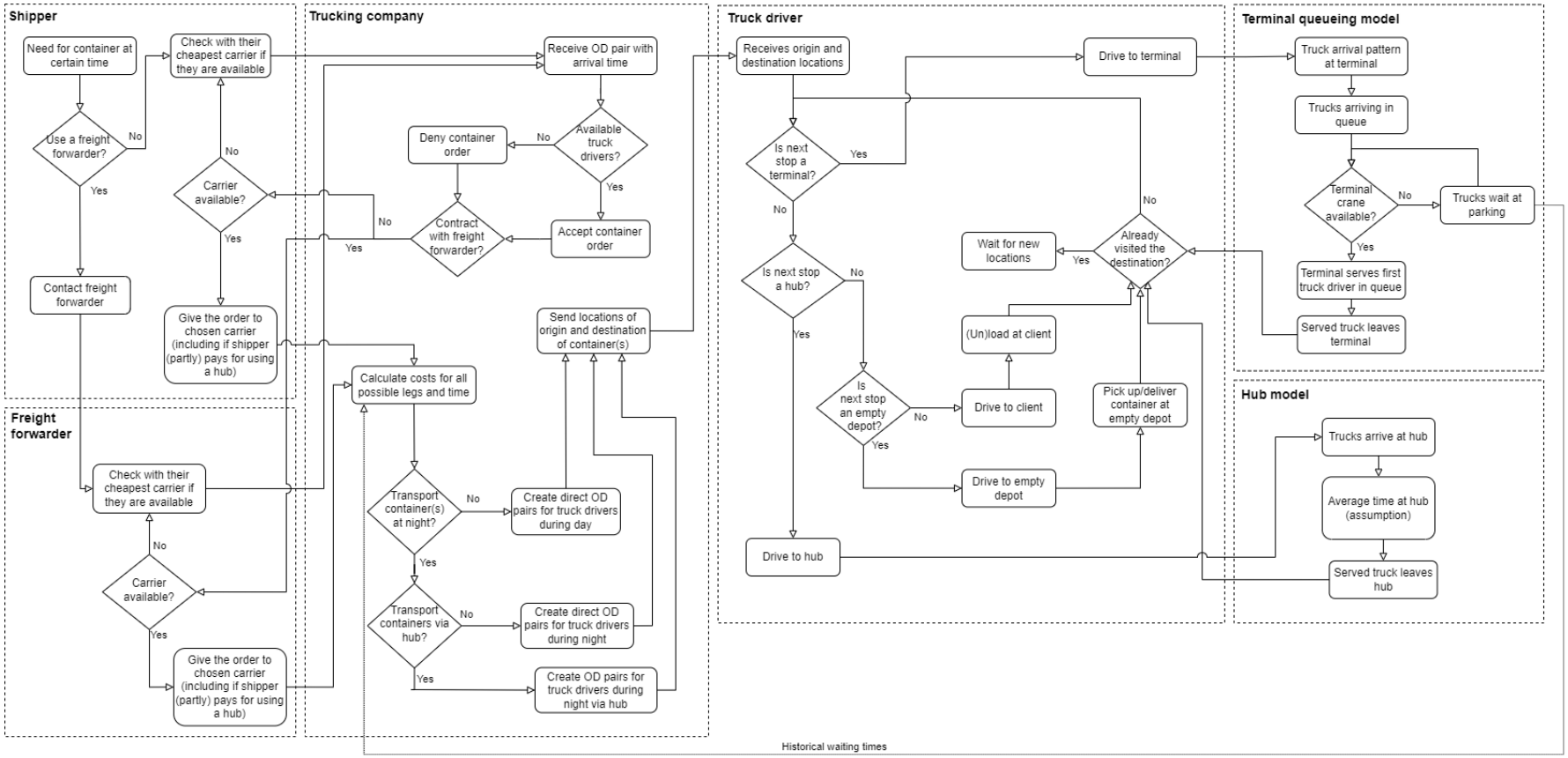

Figure C.1: Flow diagram of agent based model

D

Influences of actors' decisions

Trucking companies

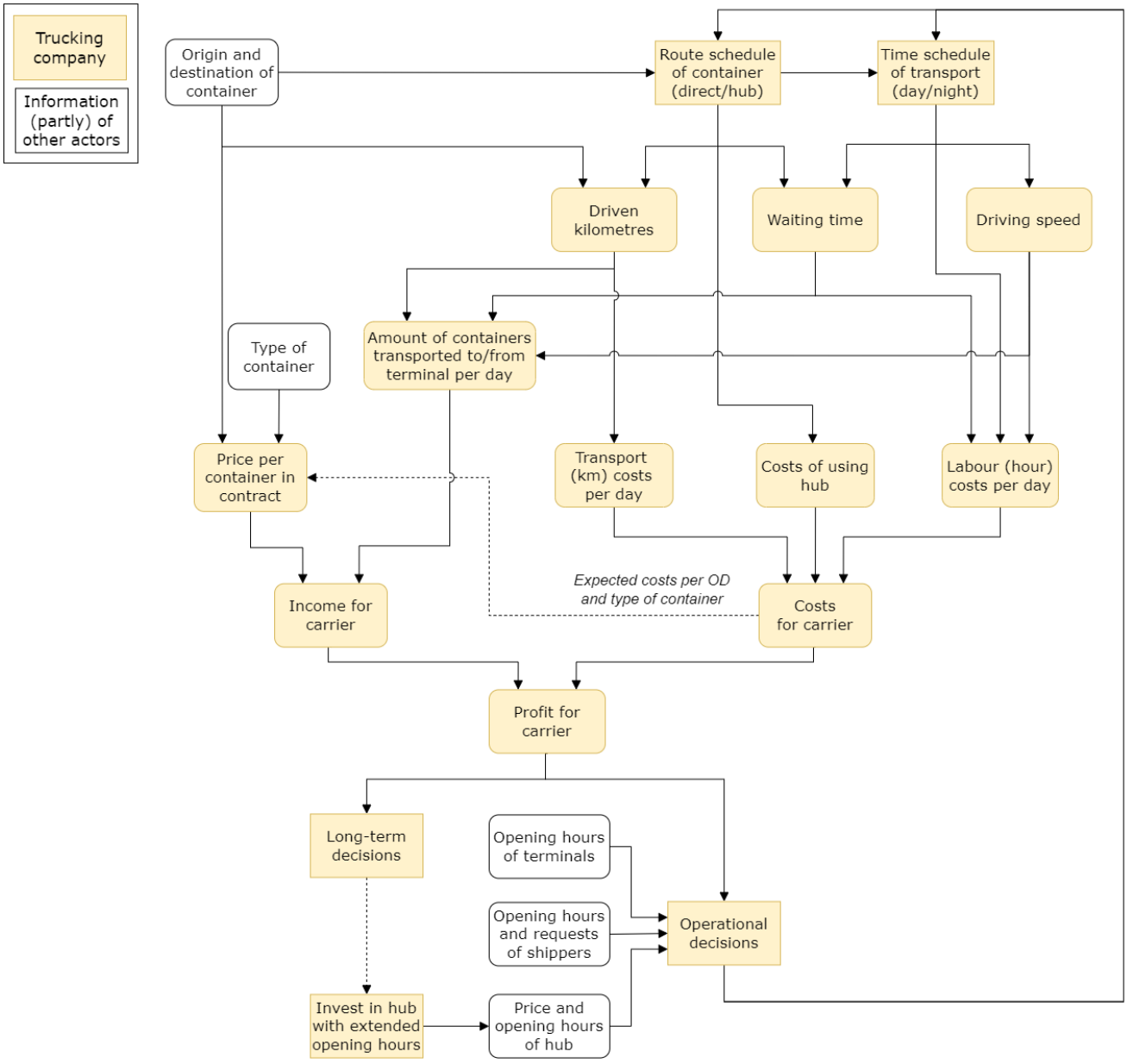

Figure D.1: Factors that influence decisions of carriers

Shippers

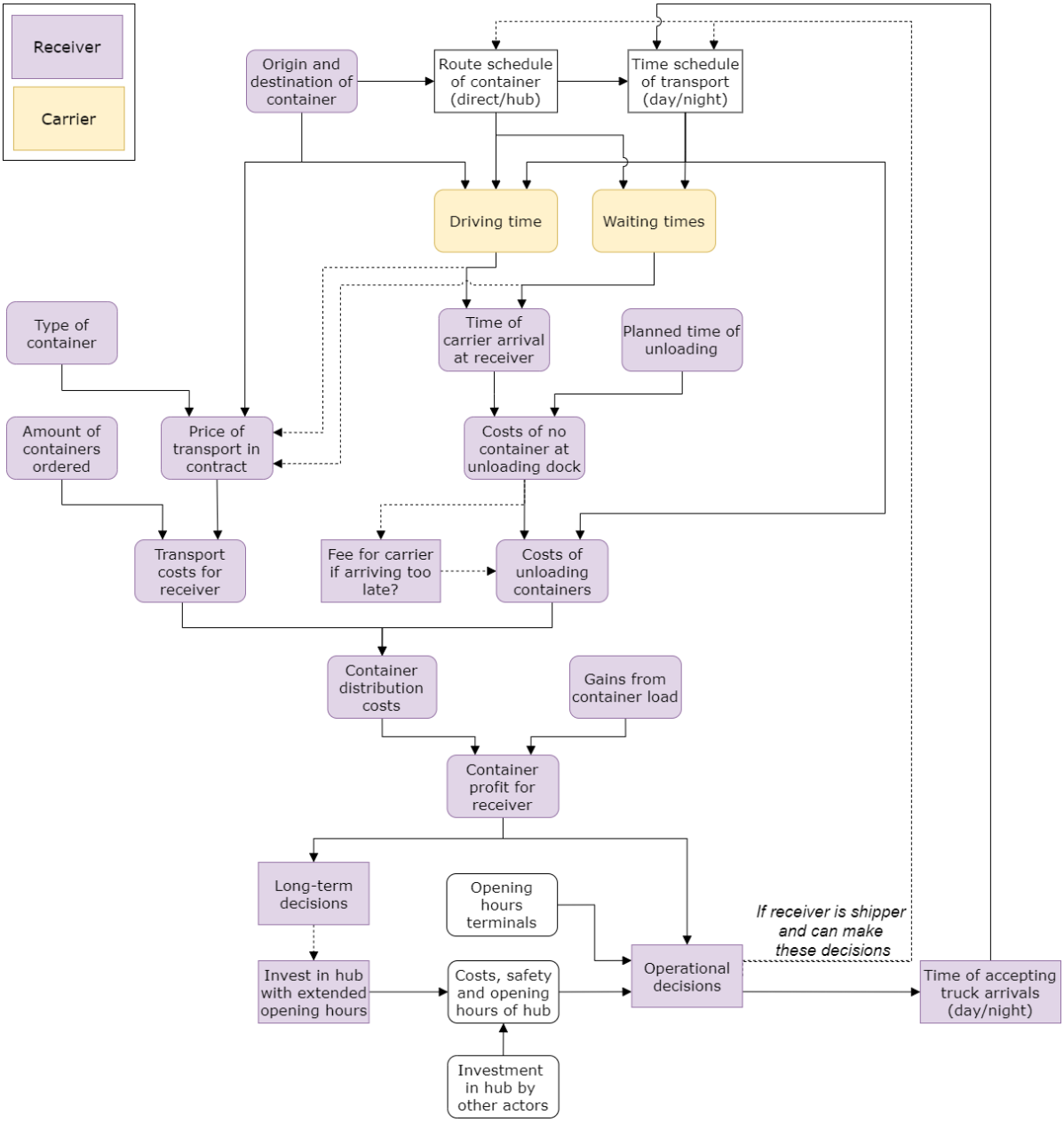

Figure D.2: Factors that influence decisions of shippers

Freight forwarders

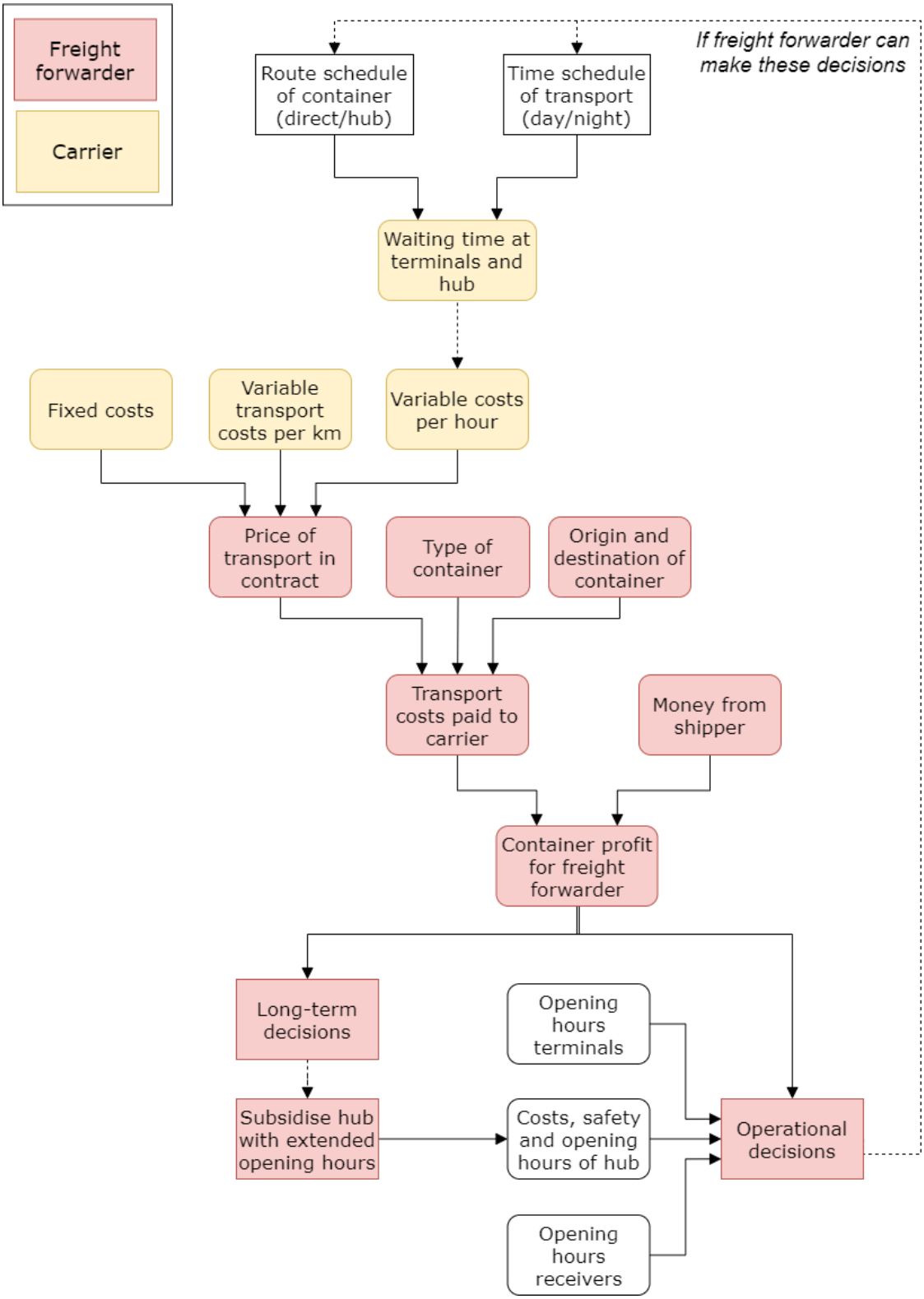

Figure D.3: Factors that influence decisions of freight forwarders

Terminal operators

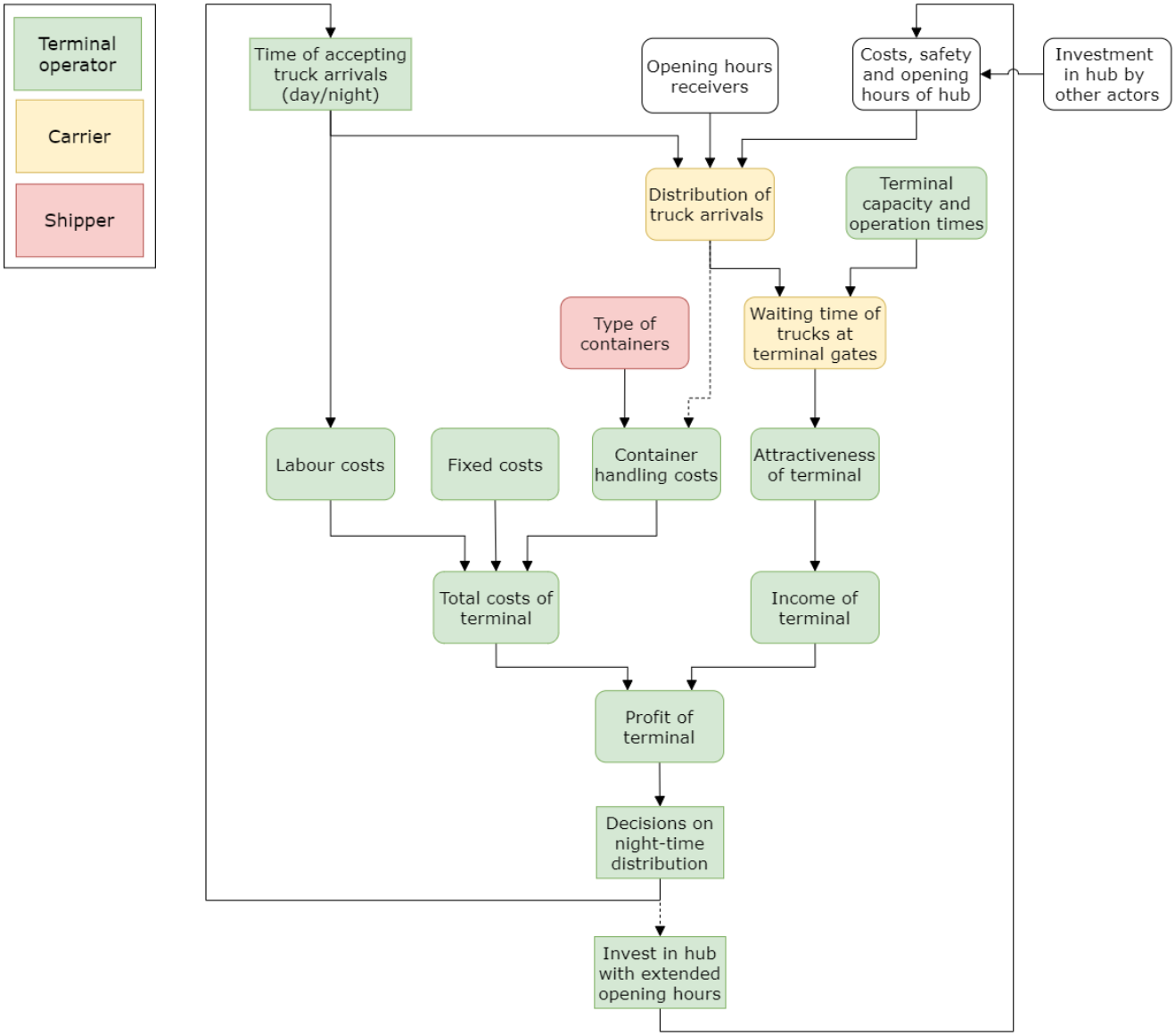

Figure D.4: Factors that influence decisions of terminal operators

Port of Rotterdam

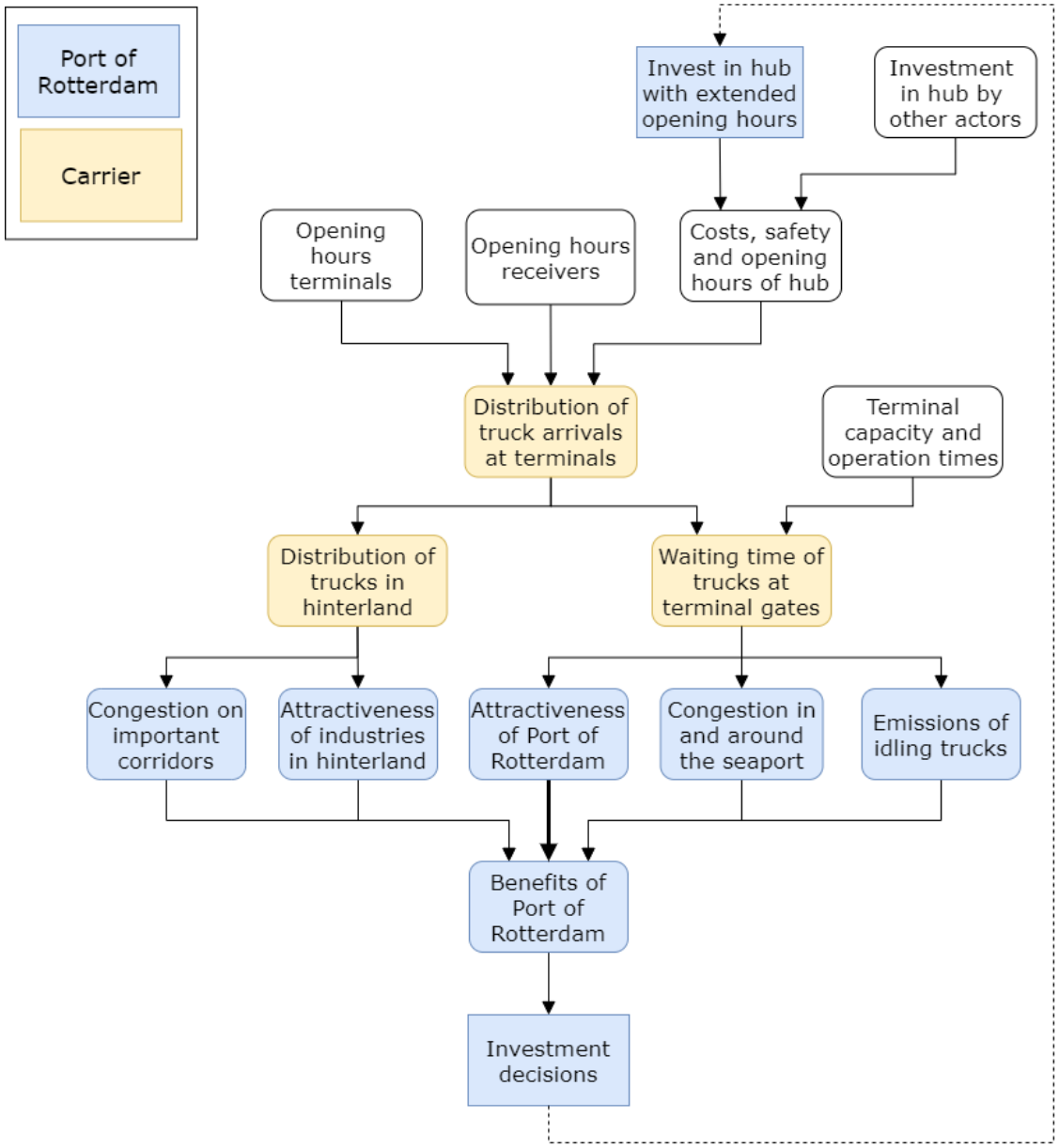

Figure D.5: Factors that influence decisions of Port of Rotterdam

Government (ministry of I&W)

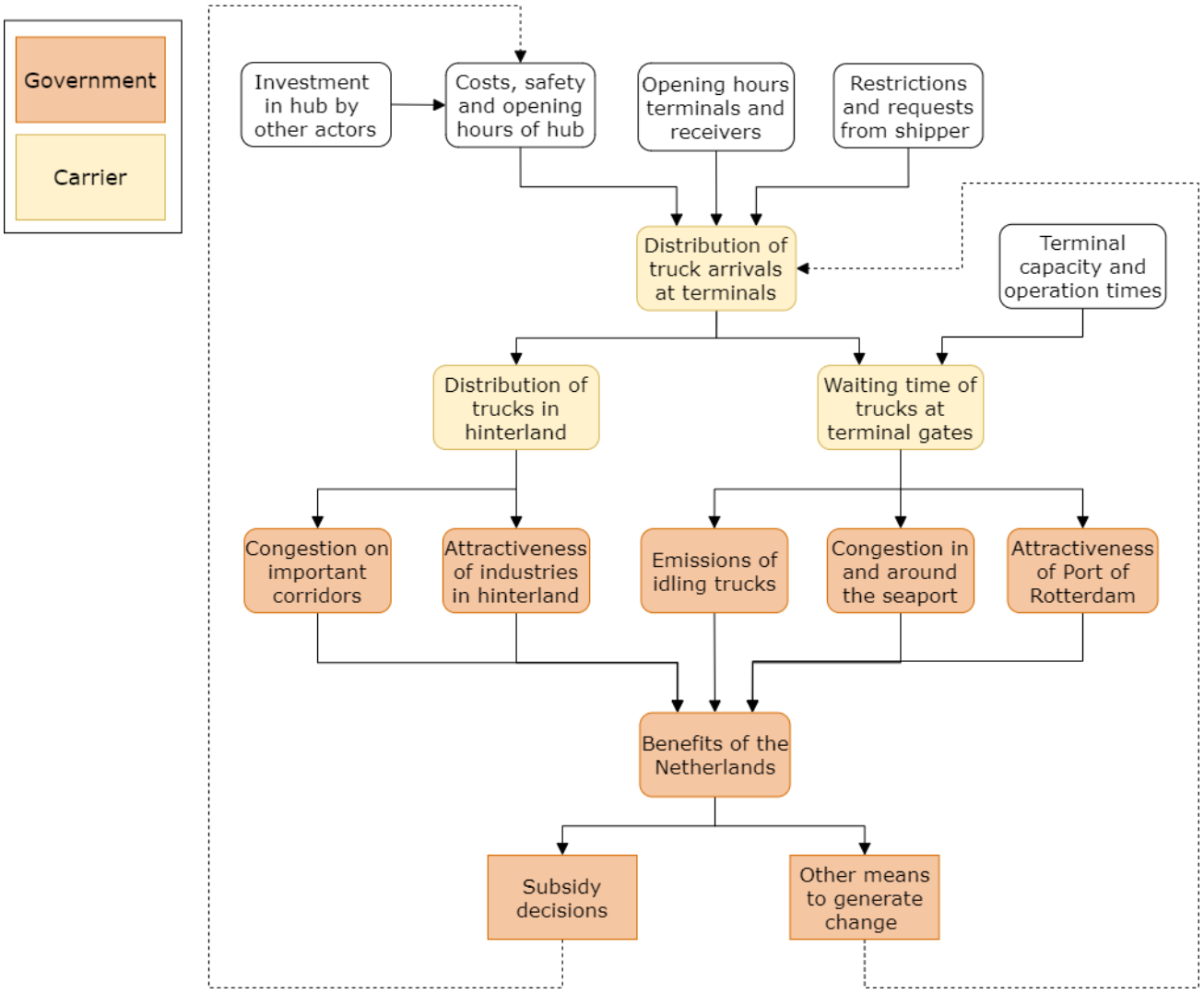

Figure D.6: Factors that influence decisions of Government (ministry of I&W)

E

Origin-destination table

Region	Terminal A	Terminal B	Terminal C	Terminal D
Region 1	121	318	376	274
Region 184	109	273	307	137
Region 189	58	78	116	89
Region 129	40	33	48	107
Region 149	40	87	85	66
Region 128	37	12	35	57
Region 27	33	25	20	17
Region 25	32	13	21	9
Region 2	31	47	17	36
Region 154	26	52	64	26
Region 79	25	1	14	21
Region 91	24	36	66	71
Region 130	21	13	29	32
Region 105	18	29	50	43
Region 106	18	35	52	40
Region 71	18	18	23	16
Region 112	15	15	20	12
Region 84	15	17	43	72
Region 92	15	27	40	21
Region 190	14	19	35	28
Region 66	14	21	25	11
Region 72	13	33	36	36
Region 73	13	47	0	47
Region 69	12	27	44	26
Region 93	12	16	30	0
Region 125	11	5	22	13
Region 101	10	22	26	29
Region 97	9	0	15	16
Region 136	8	7	22	14
Region 113	6	10	18	11
Region 74	6	6	5	13
Region 3	5	8	16	12
Region 153	4	4	17	13
Region 155	4	11	16	12
Region 121	3	2	8	24
Region 137	3	7	18	16
Region 87	3	5	9	30
Region 94	3	1	2	6
Region 50	2	2	16	16
Region 83	2	3	17	28
Region 134	1	0	15	18
Region 95	0	3	2	4

Table E.1: Trucks driving to and from every region per terminal (per day)

F

Interview questions

This appendix includes all the questions for the semi-structured interviews with trucking companies, receivers, terminal operators, freight forwarders, the Port of Rotterdam and the Ministry of Infrastructure and Water Management. In every interview, first some general questions about the company and their processes are asked. After that, questions are asked about their view on waiting times at container terminals and solutions for this. The factors at dots within questions are elements that are expected in the answers and are only asked about when not already mentioned in the answer of the question. Also some of the questions are follow-up questions and will only be asked if they are not already answered and if they are fitting within the previous answers of the actors. Since the interviews are semi-structured, they will be conversations that flow naturally. The questions will only be used and asked when they are not already covered within the story of the interviewee.

F.1. Trucking companies

General questions about company and processes:

1. What kind of carrier are you (talking about distance and type of transport)?
2. What are the distances that you transport containers to and from the terminals?
3. How many trucks does your company have?
4. How does the process of planning the transport work?
5. How do you interact with shippers, receivers, terminals, freight forwarders, depots, hubs?
6. Who makes decisions about the time window of container pick-up/delivery and how?
    - Flexibility of time window for you as a trucking company
7. How do you set-up your contracts with shippers?
    - Long-term or spot-market (outsourcing)
8. Does your company have a (shared) hub/parking place/depot and if yes; what kind of?

Questions on waiting times at container terminals:

9. Do you perceive waiting times at terminal gates' and how?
10. What do you think is the reason for these waiting times?
    - Terminal capacity and operation times
    - Distribution of truck arrivals (peak hours)
        - Restrictions from receivers and requests from shippers
        - Vessels arriving at the same time?
11. What are the consequences of these waiting times for you?
    - Less containers/kilometres transported per driver/day/week
    - Fee of arriving too late at receivers?
    - Additional costs of waiting hours
12. Do you charge shippers for the waiting times at terminal gates and if yes; how?
    - Congestion fee
13. Are there consequences for you for arriving too late at a receiver, if yes; what?
14. How do you think these waiting times could be mitigated?
    - Night-time container transport
15. Does your company perform night-time container transport at this moment and why?

16. Who chooses the time scheduling of container distribution?
    - Flexibility of time schedule for you as a trucking company
17. Do you think night-time transport (would) add/reduce costs/benefits for you and why?
    - Labour costs at night
    - Reduced fuel costs at night (less road traffic and thus more efficient transport)?
    - Reduced driving time
    - Reduced waiting time (costs) for you or other actors?
    - More containers/kilometres per driver/day/week because of night transport?
18. When would you, if not doing it already, consider transporting containers at night?
19. What are the constraints of night-time container transport?
    - Receivers not being open at night
20. How do you think these constraints could be relaxed?
    - A hub with extended opening hours
21. Are you already participating in projects to relax those constraints and if yes; how?
22. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?
23. Would you as a trucking company want to perform both the night-time distribution between the terminal and the hub and the day-time distribution between the hub and the receiver or only one of the legs and then let another (contract with a) carrier settle the other leg and why?
24. Are you collaborating/outsourcing (with) other carriers (on the spot market)?
25. Who makes what decisions about the route scheduling of a container and how?
    - Who decides if a container could pass a hub before going to the receiver?
26. What are the constraints of a hub with extended opening hours as a concept?
    - Costs and safety of hub use
27. How do you think these constraints could be relaxed?
    - Profit because of using the hub (carriers and shippers)
28. Do you think using a hub with extended opening hours would add/reduce costs/benefits for you and why?
    - Who do you think will pay for the use of such a hub?
    - Do you think using a hub with extended opening hours would lead lower costs for you or other actors (because of less waiting and driving at night)?
29. When would you use a hub with extended opening hours to reduce waiting times?
    - Costs of hub • Costs/benefits of driving at night • Lower waiting times • More often on time at receiver
30. What are the constraints of implementing a hub with extended opening hours?
    - Investing costs
31. How do you think these constraints could be relaxed?
    - Subsidy and automation of hub
    - Business case
32. To what extend do you think it would be beneficial for you to invest in a hub with extended opening hours?

F.2. Receivers

General questions about company and processes:

1. What kind of company are you?
2. At what kind of location do you receive containers (DC/depot/manufacturer)?
3. Where is this location (close/medium/far away)?
4. How many containers do you receive from and send to the terminals in the port of Rotterdam per day on average?
5. Are you (always) responsible for the transportation between the port and your location?
6. How does the process work of ordering and planning the transportation of a container?
7. How do you interact with carriers, freight forwarders and other actors?
8. How are contracts with carriers or freight forwarders created?
    - Long-term or spot market?

9. What is your role in the time scheduling of container pick-up/delivery?
    - What are your constraints on the time schedule/window and why?

Questions on waiting times at container terminals:

10. Do carriers sometimes arrive too late with the containers at your facility?
11. Do you know the reason behind late arrivals of containers? If yes; please explain
    - Waiting times at terminal gates
    - Congestion
12. Do you know what are the reasons for these waiting times at receivers?
    - Trucks all arriving at the same time (requirements from receivers)
13. What are the consequences of these waiting times for you?
14. Do you have to pay carriers/freight forwarders for the waiting times at container terminals?
15. Are there consequences for carriers for arriving too late at your facility and if yes, what?
16. What are the consequences of these late arrivals for all your processes?
    - Costs because employees are there to unload but no container
17. How do you think these waiting times could be mitigated?
    - Night-time container transport
18. Are you already doing something to mitigate these late arrivals/waiting times at terminals?
19. Does your company accept container at night and if yes/no; why?
20. What is your role in the time scheduling (day/night) of container transport?
21. Do you think being open at night adds/reduces costs/benefits for you and why?
    - Labour costs at night
    - Reduced costs for transportation because of faster transport (less waiting times)?
    - Containers being on time more often?
22. When would you, if not already doing it, consider being open at night and why?
23. What are the constraints of night-time container acceptance?
    - Higher costs for receivers to be open at night
24. How do you think these constraints could be relaxed?
    - A hub with extended opening hours
25. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?
26. What is your role in the route scheduling of a container?
    - What are your constraints (about using a hub) and why?
27. What are the constraints of a hub with extended opening hours as a concept?
    - Costs and safety of hub use
28. How do you think these constraints could be relaxed?
    - Profit because of using the hub (carriers and shippers)
29. Do you think using a hub with extended opening hours would add/reduce costs/benefits for you and why?
    - Who do you think will pay for the use of such a hub?
    - Do you think using a hub with extended opening hours would lead lower costs for you in a contract with carriers (because of less waiting and driving at night and more containers being on time)?
30. Would you pay more/less for transport of containers (to use a hub) so that containers are delivered more often on time?
    - Extra costs of using the hub
    - Less costs of waiting times
    - Less costs of unloading process (without container)
31. What are the constraints of implementing a hub with extended opening hours?
    - Investing costs
32. How do you think these constraints could be relaxed?
    - Subsidy and automation of hub
    - Business case
33. To what extend do you think it would beneficial for you to invest in a hub with extended opening hours and why?

F.3. Terminal operators

General questions about terminal and processes:

1. What kind of terminal are you?
   - Do you work with a certain commodity or sector?
2. Do you know the approximate number of trucks arriving at your terminal per day?
3. Do you know the approximate number of containers leaving from and arriving at your terminal on a truck per day?
4. How does the process work of trucks arriving at the gate?
   - Do they have to preserve a time-slot?
   - Do they announce that they come?
   - What do they do when they arrive?

Questions on waiting times at container terminals:

5. Do you perceive waiting times for trucks at your, or other terminal gates' and how?
6. What do you think are the reasons for these waiting times OR for trucks mostly arriving at day-time?
   - Distribution of truck arrivals (peak hours)
   - Vessels arrive? Receivers?
7. What are the consequences of these waiting times in peak hours OR trucks only arriving at day-time, for you as terminal?
   - Less efficient operations of the terminal?
   - Additional (container handling) costs for you?
   - Attractiveness of terminal?
8. What have you done so far to reduce the waiting times at gates OR more even distribution?
   - Time slot management?
9. How do you think these waiting times could be mitigated (in other ways)?
   - Night-time container transport
10. Are you open for truck arrivals at night and why?
    - Consequences of being open
11. Does being open at night add/reduce costs for your operations and why?
    - Labour costs
    - More efficient operations? Container handling costs?
12. Other than costs, how does being open influence your processes?
13. Is it beneficial for you to have more night-time container transport/arrivals?
14. What are the constraints of night-time container transport for you?
    - Not a lot of night-time truck arrivals
15. How do you think these constraints could be relaxed?
    - A hub with extended opening hours
16. To what extend do you think it would be beneficial for you to invest in a hub with extended opening hours?
    - Costs?
    - Consequences: more night-time truck arrivals?
17. Do you think carriers using a hub with extended opening hours would add/reduce costs for you and why?
    - Do you think you would profit from a hub with extended opening hours (more night-time distribution and less waiting times)?
18. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?
    - Costs and safety of hub
19. What are the constraints of implementing a hub with extended opening hours?
    - Investing costs
20. How do you think these constraints could be relaxed?
    - Subsidy and automation of hub
    - Business case, profit from it
21. Do you think you would possibly invest a hub with extended opening hours and how?

F.4. Freight forwarders

General questions about company and processes:

1. What service do you give as a company?
2. What are the distances that you transport containers to and from the terminals?
3. How many carriers/trucking companies are you working with, and about how many trucks do they have?
4. Does your company have a (shared) hub/depot/DC/parking place and if yes; what kind of?
5. How does the process from the which of a shipper to the transportation of containers work?
6. How do you interact with carriers, receivers, terminals, hubs?
7. Who makes decisions about the time of container transport/pick-up/delivery and how?
    - Flexibility of time window for you as a trucking company
8. How do you set-up your contracts with shippers?
    - Long-term or spot-market (outsourcing)
9. Do you sometimes let different carriers work together on one order, if yes how?
10. Do you collaborate with other freight forwarders?

Questions on waiting times at container terminals:

11. Do you perceive waiting times at terminal gates' in the port of Rotterdam and how?
12. What do you think is the reason for these waiting times?
    - Distribution of truck arrivals (because of restrictions and requests from receivers)
13. What are the consequences of these waiting times for you as freight forwarder?
    - Harder to plan
    - Extra costs for carrier or receiver?
14. Do you charge shippers for the waiting times at terminal gates and if yes; how?
15. Do you charge carriers for arriving too late at receivers and if yes; how?
16. How do you think these waiting times could be mitigated?
    - Night-time container transport
17. Do your carriers perform night-time container transport at this moment and why?
18. Who chooses the time scheduling (day/night) of container distribution?
    - Flexibility of time schedule for you as a trucking company
19. Do you think night-time transport (would) add/reduce costs/benefits for you and why?
20. What are the constraints of night-time container transport?
    - Receivers not being open at night
21. How do you think these constraints could be relaxed?
    - A hub with extended opening hours
22. Are you already participating in projects to relax those constraints and if yes; how?
23. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?
24. How would you as a freight forwarder want to arrange the night-time transport between the terminal and the hub and the day-time transport between the hub and the receiver (with one or multiple carriers) and why?
25. Who makes what decisions about the route scheduling of a container and how?
    - Who decides if a container could pass a hub before going to the receiver?
26. What are the constraints of a hub with extended opening hours as a concept?
    - Costs and safety of hub use
27. How do you think these constraints could be relaxed?
    - Profit because of using the hub (carriers and shippers)
28. Do you think using a hub with extended opening hours would add/reduce costs/benefits for you and why?
    - Who do you think will pay for the use of such a hub?
    - Do you think using a hub with extended opening hours would lead lower costs for you or other actors (because of less waiting and driving at night)?
29. When would you use a hub with extended opening hours to reduce waiting times?
    - Costs of hub
    - Costs/benefits of driving at night

30. What are the constraints of implementing a hub with extended opening hours?
    - Investing costs
31. How do you think these constraints could be relaxed?
    - Subsidy and automation of hub
    - Business case
32. To what extend do you think it would be beneficial for you to invest in a hub with extended opening hours?

F.5. Port of Rotterdam

Questions on waiting times at container terminals:

1. Do you perceive the waiting times for trucks at terminal gates' in the port of Rotterdam as a problem and if yes, how?
    - Extra costs for various actors (competition with other ports)
2. What do you think is the reason for these waiting times for trucks?
    - Terminal capacity and operation times
    - Distribution of truck arrivals (popular peak hours)
    - Opening hours of terminals and receivers
3. What are the consequences of these waiting times?
    - Congestion important corridors and in and around port of Rotterdam
    - Emissions of idling trucks
    - Attractiveness of the Port of Rotterdam and its hinterland
4. How do you think these waiting times could be mitigated?
    - Night-time container transport
5. What are the benefits of night-time container transport?
6. What are the constraints of night-time container transport?
    - Receivers not being open at night
7. How do you think these constraints could be relaxed?
    - A hub with extended opening hours
8. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?
    - Costs and safety of hub
9. What do you think are the benefits of a hub with extended opening hours?
10. What are the constraints of a hub with extended opening hours as a concept?
    - The costs and safety of using it
11. How do you think these constraints could be relaxed?
    - Profit for payers (carriers and shippers)
12. What are the constraints of a hub with extended opening hours when being implemented?
    - Investment costs
13. How do you think these constraints could be relaxed?
    - Subsidy and automation of hub
    - Business case?
14. Do you think you would possibly subsidize a hub with extended opening hours and how?

F.6. Government (ministry of I&W)

Questions on waiting times at container terminals:

1. Do you perceive the waiting times for trucks at terminal gates' in the port of Rotterdam as a problem and if yes, how?
    - Extra costs for various actors (competition of the Netherlands)
2. What do you think is the reason for these waiting times for trucks?
    - Terminal capacity and operation times
    - Distribution of truck arrivals (popular peak hours)
    - Opening hours of terminals and receivers

3. What are the consequences of these waiting times?
    - Congestion important corridors and in and around port of Rotterdam
    - Emissions of idling trucks
    - Attractiveness of the Port of Rotterdam and the hinterland (that are industries NL)
4. How do you think these waiting times could be mitigated?
    - Night-time container transport
5. Have there already been some projects in the past from the government on reducing waiting times (by for example increasing night-time container transport)?
6. Are the benefits of night-time container transport and if yes; what?
7. What are the constraints of night-time container transport?
    - Receivers not being open at night
8. How do you think these constraints could be relaxed?
    - Do you think a hub with extended opening hours could be an option?
9. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?
    - Costs and safety of hub
10. Are there benefits of a hub with extended opening hours and if yes, what?
11. What are the constraints of a hub with extended opening hours as a concept?
    - The costs and safety of using it
12. How do you think these constraints could be relaxed?
    - Profit for payers (carriers and shippers)
13. What are the constraints of a hub with extended opening hours when being implemented?
    - Investment costs
14. How do you think these constraints could be relaxed?
    - Subsidy and automation of hub
    - Other leverages (e.g., rules/restrictions night-time container transport)
    - Business case? Gaining policy? Gain sharing mechanism? What do you think?
15. Do you think you would possibly subsidize a hub with extended opening hours and how?
    - Or provincial government?

G

Interview answers

This appendix includes the answers of the interviews held with trucking companies, receivers, terminal operators, freight forwarders, the Port of Rotterdam and the Ministry of Infrastructure and Water Management. The interviews are made anonymous for this report. Since the interviews were semi-structured interviews, they were not conducted by asking one question and receiving one answer at a time, but it was more of a conversation were the interviewee told their story and if some questions were not answered, they are asked afterwards. Thus, the questions were asked and answered within the logic of each interviewee's story.

G.1. Carriers

G.1.1. Carrier A

General questions about company and processes:

1. What kind of carrier are you (talking about distance and type of transport)?

Wij doen allemaal soorten vervoer. Kort vervoer in de buurt van de Maasvlakte, maar we rijden ook naar Venlo en Duitsland. We vervoeren alle soorten containers. Ik ben gestart in 2009. We zijn een vervoerder in de Benelux en zitten in Moerdijk want dat zit tussen Rotterdam en Antwerpen.

- All sorts of transport: short (Maasvlakte), medium (Venlo) and far away (Germany)
- All sorts of containers
- I started in 2009
- Situated in Moerdijk (between the ports of Rotterdam and Antwerp)

2. How many trucks does your company have?

Wij hebben 70 eigen vrachtwagens en 30 charters. Charters zijn chauffeurs met een eigen vrachtwagen die voor ons werken.

- We have 70 own trucks and 30 charters that work for us

3. How does the process of planning the transport work?
4. How do you interact with shippers, receivers, freight forwarders?
5. How do you set-up your contracts with shippers?

We hebben een klantenbestand van ongeveer 80 klanten die constant boeken. Van deze klanten is ongeveer 90% expediteur en ongeveer 10% een verlader zelf. Een bepaalde expediteur kan bijvoorbeeld 20 containers per dag willen vervoeren, met vaak vaste bestemmingen. Expediteurs bepalen vaak hun eigen regels en verladers gaan meer in gesprek. We werken niet echt met contracten, maar gewoon met langdurige klantenbestanden. Een klant die transport wil, wil bijvoorbeeld een container van de haven naar hun loods krijgen. Deze komen dan bij onze planning afdeling. Die gaan dan samen de planning regelen van de container. Daarna gaat het naar onze boekingsdesk. De boekingsdesk plant dan echt het vervoer van de container met een vrachtwagen. Een chauffeur die net een container ergens heeft afgegeven, krijgt een nieuwe opdracht en kan weer vertrekken. Prijs bepalen we op basis van km/uur.

- We have around 80 clients. Those clients book constantly
- Around 90% of the clients are freight forwarder; they make up their own rules. Around 10% are shippers

- A freight forwarder wants for example to transport 20 containers a day. They often have standard destinations
- We don't really work with contracts. We just work with long lasting clients
- When a client orders transport, they for example want a container to go to a warehouse. He will contact our planning department. They will arrange something with the client and go to our booking desk. The booking desk sends this again to our own planner, that arranges the transport with one of our truck drivers. Whenever a truck driver is finished with a job, he will receive the next job
- The price of transport is based per km per hour

6. Who makes decisions about the time window of container pick-up/delivery and how?

Klanten stemmen (samen met vervoerder) de tijd dat een container bij de klant moet zijn af. Soms wil de ontvanger echt een bepaalde tijd. Dat tijdstip wil niet altijd lukken door de wachttijden bij de terminals. Wij proberen als vervoerder wel altijd een flexibel tijdvenster te regelen, en waarschuwen als een bepaalde tijd niet gaat lukken door wachttijden. Soms probeert de ontvanger een boete te geven als wij te laat aankomen, maar dat doen wij niet. Misschien andere vervoerders wel maar wij niet. Als een klant zo doet, dan vervoeren wij daarna niet meer voor hen.

- In consultation with everyone (sometimes the receiver wants to choose)
- We agree on time. But that time does not always work out (because of waiting times)
- We try to agree on flexibility, and warn them if the time will not work
- Some receivers try to give a penalty if we arrive too late; but we don't pay that

7. Does your company have a (shared) hub/parking place/depot and if yes; what kind of?

Ja, wij hebben een vrachtwagen-parking bij het Marconiplein in Rotterdam en een hier in Moerdijk. In Moerdijk hebben wij ook een eigen hub waar wij containers kunnen afkoppelen en opslaan. Dit doen wij om wachtkosten en congestie te voorkomen en vermijden. Als we al een container hebben opgehaald bij een klant, maar het is heel druk in de haven, dan houden we hem bijvoorbeeld bij de hub. Of we halen al eerder een container op bij de terminals als het rustig is, houden hem dan bij de hub en brengen hem later bij de klant. We zijn ook aan het kijken of het mogelijk is om zo'n interne hub te creëren in Rotterdam.

- Yes we have a truck parking at Marconiplein (Rotterdam) en one here (Moerdijk)
- Also an (internal) hub where we disconnect containers and store them in Moerdijk. To prevent and avoid waiting costs and congestion. So if there is congestion at the port and they want to wait to go there, or if the container may not yet go to the receiver, they place it there for a while.
- Are looking now if a hub in Rotterdam is also possible

8. Who makes what decisions about the route scheduling of a container and how?

Wij kunnen bepalen of een container langs onze hub gaat. Een klant wil gewoon een container op een bepaalde tijd bij hun deur. Maar een hub kost ons wel geld, dus als wij dat willen van de klant, moet die daar natuurlijk wel mee akkoord gaan, anders betalen wij.

- We can make the decision if the container will first pass the hub.
- A customer only cares that the container will be at their location at a certain time
- However the hub costs money, so if we want the client to pay that, they have to accept that. Otherwise we pay it.

Questions on waiting times at container terminals:

9. Do you perceive waiting times at terminal gates' and how?
10. What do you think is the reason for these waiting times?

Ja er zijn zeker wachttijden bij de terminals. Schepen die bij de terminals binnen komen worden steeds groter. Bij sommige terminals is de infrastructuur minder goed dan bij anderen. Ook komen alle vrachtwagens tegelijk. Dat komt door de klanten die allemaal op dezelfde tijd hun container willen. Het is dus een ketenprobleem. Het is 1 locatie waar teveel handelingen tegelijk worden uitgevoerd door heel veel partijen. Elke klant wil zijn containers geleverd tussen half 8 en 4 uur 's middags zodat ze hem kunnen uitladen. De prijs voor vervoer van de haven naar klant is zo laag dat je je container niet echt zomaar kan ophalen op een ander tijdstip, zoals in de nacht. Daar heb je dan een hub voor nodig en een goede strategie. Je hebt dan een coördinator van containers nodig en eigenlijk moet je er voor kiezen om alles direct op te halen van de terminal of alles via de hub te doen. Een mix is lastig want dan kan je niet meten of het rendabel is wat je doet.

- Yes there are waiting times at container terminals, because:
- Ships are getting bigger
- Sometimes infrastructure of terminals is not good
- Everyone arrives at the same time: because of customers wishes, it is a chain problem
- Too many operations at 1 point all at once
- Customer wants containers delivered between half past 7 and 4 o'clock
- The price is so low that you cannot pick up your container at another time: thus a hub is needed
- Driving at night can save waiting time, but costs money. And when using a hub, an extra coordinator is needed.
- If some carriers use a hub, for other carriers the terminal will automatically be less congested (without doing anything)
- Either let all containers go via the hub or all direct from the terminal. A mix is difficult because it is hard to see what is profitable

11. What are the consequences of these waiting times for you?

Als gevolg kan je minder containers ophalen bij een terminal in 24 uur. Eigenlijk kan je 22 uur effectief werken, want in 24 uur zitten 2 shiften van 12 uur en een chauffeur heeft 1 uur pauze nodig. Maar de wachttijden hebben invloed op hoeveel containers je nou echt kan ophalen. Als je door de wachttijden 2 uur te laat bent en niet meer kan laden/lossen bij een klant, moet je met de klant gaan bespreken wat je doet. Ga je hem op de hub zetten? Iemand moet daar dan voor betalen. We kunnen alleen zelf de kosten dragen als we het hele proces veranderen. Het probleem is dat er te veel volume aan komt met te grote boten. Wij moeten ook rekening houden met merge and detention costs (de kosten dat een container op de terminal staat en niet opgehaald wordt). Die kosten belasten we wel door aan de klant en zijn expediteur. De rederij kan er voor kiezen dat een container er bijvoorbeeld 3, 8 of 10 dagen gratis mag staan, voordat de merge and detention costs gaan komen. Stel, er komen bij RWG 10.000 containers binnen 3 dagen aan. Daarna kost het 70/80 euro per dag om de container daar te laten staan; dan wil iedereen dus binnen 3 dagen 10.000 containers ophalen bij RWG. Er was een keer een storm waardoor de terminal een tijdje dicht was. En het is een terminal met tijdsloten, dus je kan niet de hele dag opzetten. Als je dan je container op zaterdag wil ophalen, maar er zijn al 3 dagen voorbij, kan dat niet omdat de rederij dan eerst geld wil zien (merge and detention costs). Dan kan de container pas maandag of dinsdag opgehaald worden. Dit zijn problemen door de drukte bij de terminals.

- Less containers transported per day
- If hour too late because of waiting times and you are not allowed to go to the customer anymore: need to discuss going to a hub. Discuss with client: who is going to pay? Different per client
- If the whole process changes: a carrier can bear the costs because it will be more profitable to use the hub
- The merge and detention costs (paid to deep sea carrier if container stays too long on terminal, we charge that to the customer). The free period at the terminal can be for example 3, 8 or 10 days. Then, the forwarder and his customer pay the merge and detention costs. Assume 10.000 containers arrive at the RWG terminal and need to be picked up within 3 days (70/80 cost per day thereafter). Thus, everyone wants to collect 10.000 containers within 3 days. At some point there was a storm and the terminal was closed for a while. Its a time slot driven terminal: thus we couldn't pick up a container the day after the storm. Then, the 3 days were over and we wanted to pick up on Saturday, but have to wait on Monday or Tuesday, because they first want to see the money for the merge and detention costs.

12. Do you charge shippers for the waiting times at terminal gates and if yes; how?

Ja, de kosten van gemiddelde wachttijden rekenen we door naar de klant. Als we uiteindelijk veel langer bij een terminal hebben moeten wachten, gaan we daarna in gesprek met de klant. En dan is het per klant verschillend of ze er dan zelf nog wat extra voor betalen.

- We charge shipper for an average waiting time. If the waiting time is higher: we go in conversation after. It depends per customer if we get the money back.

13. How do you think these waiting times could be mitigated?

Door minder grote schepen, de infrastructuur bij terminals te verbeteren. En door niet allemaal tegelijk aan te komen, dus meer vervoer van containers in de nacht.

- Smaller ships, better infrastructure at terminals and to not all arrive at the same time at terminals (thus night transport)

14. Does your company perform night-time container transport at this moment and why?

Ja, wij hebben 6 a 7 vrachtwagens die 's nachts rijden om de wachttijden te omzeilen. Het liefst rijden deze al meteen naar de klant toe. Die hebben een elektronisch hek en dan kunnen we het gewoon op hun terrein zetten en kunnen ze er 's ochtends mee aan de slag. En als dat niet kan, moeten de containers naar onze eigen hub. In de nacht is het rustiger bij de terminal, maar is er ook minder personeel. Daardoor sta je 's nachts toch soms ook ineens 1,5 uur te wachten, als het personeel bijvoorbeeld pauze heeft ofzo.

- Yes we have 6/7 trucks that drive at night. Preferably drive to the customer; with an electronic gate
- But some terminals have few staff at night: sometimes you stand waiting for 1.5 hours.

15. Who chooses the time scheduling of container distribution?

Wij kunnen zelf als vervoerder bepalen of we containers in de nacht of overdag ophalen. De klant wil namelijk niks extra's betalen voor nacht vervoer. Dus daarom rijden we het liefst meteen door naar het warehouse van de klant in plaats van naar onze eigen hub. De klant wil niet voor de hub betalen. Dus als je een container naar de hub brengt, moet je dat zelf terugverdienen als vervoerder omdat je niet hebt gewacht bij de terminals overdag. Het is echt een rekenschema: bij hoeveel containers gaat het lonen?

- We can determine if we pick up containers at day or night.
- The customers do not want to pay anything extra for use of our hub at night (so preferably directly to the customer)
- You have to earn back the hub use as carrier: it is really a calculation scheme (at how many containers does it pay off?)

16. How does night-time container transport influence your processes?
17. Do you think night-time transport (would) add/reduce costs for you and why?

De loonkosten zijn 's nachts iets hoger, maar je doorlooptijd is ook sneller dus dat maakt het weer goedkoper. En het gevolg is dat we meer containers per dag kunnen transporteren van en naar de terminals.

- The labour costs are a bit higher but everything is faster so that evens it out
- As a consequence we can transport more containers per day so we would be more profitable

18. What are the constraints of night-time container transport?

Klanten van ons zijn alleen overdag open. Dus die willen 's nachts geen containers ontvangen.

- Most of our customers are only open during the day.

19. How do you think these constraints could be relaxed, apart from your own hub?

Ja een gedeelde hub die 's nachts open is voor meerdere vervoerders, kan zeker een goede oplossing zijn. Maar dan moet je wel goed kijken wat voor vervoerders het zijn. Hoe werkt het precies en hoe ga je het laten slagen? Je wil eigenlijk zo min mogelijk moves maken met een container want dat kost geld. Je moet dan zorgen dat als een vervoerder een container aflevert bij de hub en daarna naar een terminal gaat, ze meteen een andere container meekrijgen voor diezelfde terminal. Ze moeten dus hun eigen container los laten en zo efficiënt mogelijk de hub gebruiken. Als je bijvoorbeeld een container moet ophalen van RWG, en je hebt er een voor Euromax, dan drop je die van Euromax bij de hub en neem je er een bij van RWG, zodat je maar langs 1 terminal moet op de Maasvlakte. Voor de extra kosten van zo'n hub draaiende houden: wie gaat dat betalen? Je hebt een klant of terminal nodig. Ontvangers, terminals en vervoerders moeten allemaal samen de kosten dragen want die krijgen allemaal winst. De vervoerder wordt rendabeler, de terminal beschikbaarder en de klant krijgt zijn containers op tijd (want in de toekomst namelijk minder zeker gaat zijn), omdat je met de hub strakker kan plannen.

- Shared hub can indeed be a good solution. But decide carefully on what kind of participants
- Normally you want to make as few moves as possible: because that costs money.

- Switch containers at hub to be efficient: which terminal are you going to and thus switch containers to only stop at 1 terminal
- If you have 25 trucks and you have to decide all day whether to use the hub: need of extra coordinator
- In order for the extra costs of coordination: need of payment from customer and/or terminal. Terminal, carrier receiver all have to bear the costs together, because they profit from it. Carrier will be more profitable. Terminal will be more available. For the customer the advantage is that the container is more often on time. Because with a hub, you can plan much tighter.

20. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?

Ik denk dat als je als eigen vervoerder zoiets maakt, een chassis-exchange beter zou kunnen zijn. 1 trailer per dag is goedkoper dan 2 moves. Maar trailerkosten worden wel hoog. Op kleine schaal zou dat goed werken, als chauffeurs ten minste hun trailer willen afstaan aan een andere chauffeur binnen die vervoerder. Maar gezamenlijk met meerdere vervoerders moet je chassis niet gaan uitwisselen. Dat is te lastig, dan ben je je trailer kwijt. Een container hub waarbij je de container achterlaat is voor meerdere vervoerders een goede oplossing als het goed regelt wordt. En bij een klant containers afkoppelen werkt ook goed, dat doen wij al bij een aantal klanten.

- I think a chassis exchange is better for only one carrier (not shared with other carriers because drivers don't like sharing their chassis and especially not with another carrier; it gives problems).
- 1 trailer per day is cheaper than 2 moves (at a hub). But the trailer costs will become high
- For carriers working together; a container hub might be a good solution
- Many containers are uncoupled at customers. We do that a lot already.

21. What would be reasons for you to (not) use a hub with extended opening hours?

Wel omdat je daardoor minder hoeft te wachten en dus meer containers kan vervoeren per 24 uur. Maar niet als we in ons eentje alle kosten moeten dragen en er niet genoeg uit halen. Het is echt een rekensom. Dan zou je het met alle containers moeten doen of niet, om te kijken of het rendabel is.

- Depending on if it would be profitable for us

22. Do you think using a hub with extended opening hours would add/reduce costs for you and why?

Als het goed geregeld is zouden we ervan profiteren, omdat we rendabeler worden van minder wachten als het niet te veel nieuwe kosten brengt. De prijs voor transport voor de klant zal nooit minder worden omdat de prijs al tegen de scherpste snede gaat (125-140 euro). Een klant zal nooit minder moeten gaan betalen voor het transport.

- If it is implemented in a good way, we could profit from it
- The price will probably not become lower for clients, as it is already very low

23. Would you as a trucking company want to perform both the night-time distribution between the terminal and the hub and the day-time distribution between the hub and the receiver or only one of the legs and then let another (contract with a) carrier settle the other leg and why?

Je moet de container loslaten om het efficiënt en rendabel te maken. Dus je kan beide soorten vervoer doen, maar niet per sé beide legs van 1 containers. Als je met andere vervoerders samenwerkt bij een hub moet je een overeenstemming maken van hoe je het invult. Hoeveel en welke auto's rijden er overdag en 's nachts? Je moet samen een planning. Als je dan een container inlevert, laat je hem los. Er moet 1 iemand zijn die alles coördineert.

- If you work together you will have to make discussions on how many cars will do what: make a planning together. You should drop off a container at the hub and let it go (let the day transport possibly be done by another trucking company than the night transport). You need someone for coordination

24. Are you collaborating/outsourcing (with) other carriers (on the spot market)?

Ja, we doen dat op het moment al heel veel. Dan mail of bel je een andere vervoerder en dan vraag je of zij ritten kunnen overnemen of dat jij er wat kan overnemen.

- Yes we already do that a lot by calling and emailing other trucking companies to take over some transport

25. What are the constraints of a hub with extended opening hours as a concept?

Het probleem is dat als het rustig is bij de terminals, de vervoerder geen zin heeft om extra te betalen voor het gebruik van de hub, maar dat als het druk is, hij wel naar de hub wil. Het is dus elke keer weer een menselijke beslissing en opnieuw de afweging. Als jij 25 vrachtwagens hebt en je moet de hele dag beslissen of je langs de hub gaat: heb je een extra persoon daarvoor nodig. Ook wil niet elke vervoerder zijn container afkoppelen, sommige willen gewoon 1 job doen. Verder kan een probleem zijn als het té druk wordt bij de hub (500/800/1000 containers?). Hoeveel containers ga je daarheen verschuiven?

- If the trucking company sees that it is not busy at terminal he would want to not use the hub, but if it is busy he does: human choice that is different every time
- Trucking companies will have to accept to only transport one leg of the container
- You don't want to move the waiting times to the hub: how many containers do you want to move?

26. How do you think these constraints could be relaxed?

Om te zorgen dat je niet té veel containers per hub krijgt, kan je de markt opdelen in groepen. Grote vervoerders met heel veel auto's kan je groeperen in 5, 10 of 20. Eenlingen kan je groeperen per 50, dan heb je ongeveer evenveel auto's per groep. Dan zorg je dat die groepen vervoerders aparte hubs hebben. De extra persoon die je nodig hebt om alles te coördineren bij de hub; moet worden betaalt door iedereen die er profijt van heeft. Dat zijn niet alleen de vervoerders, maar ook de terminals en de klanten. Voor de klant (ontvanger) kan er nu namelijk veel strakker gepland worden (container weg vanaf hub zonder wachttijd i.p.v. weg vanaf een drukke terminal). Je gaat de terminal op meerdere stromen bedienen. De klant gaat voor stabiliteit. Want ze kunnen wel 100 euro bijvoorbeeld niet steken in containers op tijd, maar dan gaat die 100 euro naar een losploeg die er voor niks staat. Je kan dat geld ook besteden aan een hub zodat de containers er op tijd zijn.

- Separate the market in groups (large trucking companies in groups of 5/10/20, one person companies in 50) and make several hubs
- Containers will be less often too late at the client, the transport is much more stable. They can pay money for hub use or for their employees that are not doing anything because a container is too late

27. What are the constraints of implementing a hub with extended opening hours?

De kosten van investering in zo'n hub zijn er natuurlijk ook. Wie gaat er betalen voor het neerzetten van de hub?

- Cost of investing

28. How do you think these constraints could be relaxed?
29. Do you think you would possibly invest a hub with extended opening hours and if yes; how?

Ik zou zeggen dat dit is iets voor het havenbedrijf om te betalen. We hebben wel eens aan het havenbedrijf gevraagd om een stukje grond. Dat zat er tot nu toe nog niet in. Ze moeten iets beschikbaar stellen (de huur daarvoor moet een beetje evenredig zijn zodat we er profijt uit kunnen halen; en vanuit daar is het project). Het zou ook gunstig zijn voor het Havenbedrijf om de wachttijden te verminderen dus ze zouden hier mee moeten helpen. Als vervoerder zouden wij ook willen investeren, omdat het gaat werken. Dat zouden klanten ook moeten zien: als je kan aantonen dat het gaat werken; zouden zij ook willen investeren. De beladingsgraad én de aanlevergraad gaan voor hen omhoog. Dat is iets voor de ontvangers om in te investeren.

- The Port of Rotterdam could invest in their own port by paying for the ground of a hub
- Trucking companies will want to invest
- Show to customers that the load factor and delivery rate are going up, then they will want to invest.

Het is geen simpel systeem, er moet veel met de hand (bepalen of je naar een hub gaat). Wij doen ook veel kort werk (zoals Post en Zonen) en dat hoeft niet altijd precies rendabel te zijn. Of klanten akkoord gaan met zo'n hub: hoe belangrijk is het dat jou spullen geleverd worden? "boeit me niet zoveel, maar op tijd, niet meer betalen" zeggen sommigen. Maar hoe denk je dan dat het op je af komt? Ik vraag aan klant meer betalen: wil die vaak niet. Maar je wil toch een fatsoenlijke chauffeur voor de deur? Uiteindelijk moeten ze het wel gaan willen. Depots moeten ook open zijn.

G.1.2. Carrier B

General questions about company and processes:

1. What kind of carrier are you (talking about distance and type of transport)?

Wij zijn actief in bouwmaterialen en in containers. Ongeveer de helft van mijn vrachtwagens doet zeecontainers, de andere helft bouwmaterialen.

- Half of trucks transports containers, other half building materials

2. What are the distances that you transport containers to and from the terminals?

We vervoeren op korte afstanden van en naar de terminals. Rond de 30 kilometer.

- Short distances (30 km from the terminals)

3. How many trucks does your company have?

We hebben ongeveer 70 a 80 vrachtwagens die per dag zeecontainers vervoeren.

- 70 to 80 trucks that transport containers every day

4. How does the process of planning the transport work?
5. How do you interact with shippers, receivers, freight forwarders?

Dat is klantverschillend. We hebben veel vaste klanten met jaarovereenkomsten. Sommige klanten communiceren met onze planning hoeveel transport ze hebben, per email. Bij andere klanten hebben we een direct inlees systeem. Of wij kijken zelfs hun eigen portal in. We hebben een grote klant waar wij hun huisvervoerder zijn; dus al hun containers laden en lossen op hun terrein. Zij zijn een op en overslag bedrijf, waarna de producten dus weer verder reizen (dus zij zijn niet de eigenaar van de lading). Met hen hebben we directe communicatie, maar verder communiceren we vaak met expediteurs en rederijen. Ook rederijen regelen namelijk transport (import én export): carrier haulage.

- Different per customer. We mostly have yearly agreements.
- Some clients communicate with our planning per email, with others we can look in their portal
- We have one large client where we do all their containers, we communicate with them directly
- Otherwise normally we communicate with freight forwarders and deep sea carriers (that both arrange transport)

6. Who makes decisions about the time window of container pick-up/delivery and how?

De klant bepaalt wanneer de container voor de deur moet staan. Dat is verschillend per opdracht. Soms zeggen ze dat we er specifiek om 8 uur moeten zijn. Maar het kan ook dat er voorraadproducten zijn, dan zeggen ze gewoon vandaag tussen 7:00 en 15:00 is prima. Wij hebben behoorlijk veel voorraadproducten, omdat onze grootste klant dat veel heeft. Dus de klant bepaalt hoe laat we er moeten zijn, maar het maakt ze niet uit wanneer wij de container ophalen bij de terminal (die ochtend of de dag ervoor). Wij zitten natuurlijk wel gebonden aan sommige kaders, zoals wanneer de container is vrijgesteld.

- Customer/receiver determines when the container should be at their location
- Different per container (sometimes has to be there at 8:00, but also stock products (7-3)
- We have quite some stock products for our largest customer
- Customers do not care when we pick up the container at the terminal (if it is there on time)
- We are bound by some frameworks (like when is the container released)

7. How do you set-up your contracts with shippers?

Normaal hebben we gewoon lange termijn contracten met klanten. Daar zitten natuurlijk voor- en nadelen aan. Het voordeel is dat we zo een relatie opbouwen met de klanten. Alleen door de huidige drukte van de markt is er nu juist ook veel te halen uit de spotmarkt, omdat er weinig transporteurs zijn. Daardoor kan je wel veel verdienen op de spotmarkt

(zoals U-turn), maar het is niet zo betrouwbaar als langdurige klant contacten natuurlijk. We doen ook wel eens orders via andere transportbedrijven.

8. Does your company have a (shared) hub/parking place/depot and if yes; what kind of?

Nee wij zelf niet. Onze grootste klant heeft een grote locatie waar wij een beetje mee kunnen spelen. Bijvoorbeeld als een terminal druk is, kunnen we de containers morgen ophalen in plaats van vandaag. Dit lukt natuurlijk niet altijd, want soms heeft de klant ze echt nodig. Om op die korte afstand zelf een hub te gaan neerzetten is voor ons denk ik niet rendabel.

Questions on waiting times at container terminals:

9. Do you perceive waiting times at terminal gates' and how?

Ja hier hebben we veel mee te maken want we zitten op korte afstanden dus we zijn relatief vaak bij de terminals. Dit jaar zijn de wachttijden opgelopen met 11 procent. Omdat we op korte afstanden zitten, zijn de terminaltijden erg belangrijk. Meestal zijn we ongeveer 1,5 uur per container bij een terminal, bijvoorbeeld 1 uur opzetten en een half uur inleveren. Als dat met 11 procent oploopt, beïnvloedt dat zeker onze kostprijs. Omdat we relatief veel auto's hebben en op korte afstanden zitten, zijn we altijd naar combinaties aan het zoeken. We willen eigenlijk altijd voor een dubbele order een terminal opgaan, 1 container afzetten en 1 ophalen, voor de efficiëntie.

10. What do you think is the reason for these waiting times?

Er komen te veel auto's tegelijk. De terminals zeggen dat we op andere tijden moeten komen. Of de terminal is niet ingericht op piekcapaciteit, want ze weten toch dat we komen. Tegenwoordig zijn er 2 terminals die met tijdsloten werken. Maar zelfs als er geen wachtrij is, is er wel een virtuele wachtrij wel. Volle containers die naar de RWG willen, maar als er pas om 4 uur plek is; als een container daar moet zijn dan gaan we dat plannen, maar moet je misschien de hele tijd wachten als je container al op chassis hebt staan. Ziet RWG niet in hun wachttijd terug. Proberen wij te vermijden door 2 tijden bij elkaar te hebben (wanneer is die tijd er? Je moet dus goed kijken en plannen van tevoren). Zelf ben ik een voorstander van terminals met tijdsloten (onze planning vindt het lastig want vooruit kijken; maar als je eroverheen kijkt): onze klant betaald prijs per container, die terminalprijs wordt erin verekend (gemiddeld). Wij geven prijs op per container per traject per jaar. Volgend jaar rekenen wij dan 11% meer in de prijs. Maar als het het jaar daarna 2 uur is; dan hebben we weer een probleem. Sommige vervoerders geven 1 uur wachttijd vrij (zonder geld te vragen aan klanten) en daarna de klant belasten als ze er langer staan. Wij doen vaak dubbel werk: wie betaalt dan de extra kosten bij de terminal? Als je 1,5 uur wacht om in te leveren en half uur om op te halen: kan je niet bewijzen voor welke container dat was (en veel administratie). Dus geef je het aan in prijs; maar dan is er wel betrouwbaarheid nodig (tijdsloten zijn dus fijn; dan heb je minder onverwachte wachttijd). Zonder tijdslot is het veel meer variabel: dan duurt het soms ineens 3 uur. Los van dat het kosten technisch beter uitkomt: ook je betrouwbaarheid ten goede; dan ben je minder vaak te laat bij de klant.

11. What are the consequences of these waiting times for you?

Als voorbeeld kan je hebben dat onze klant die container niet gaat lossen als we te laat aankomen, want dan is er geen losploeg meer (dan blijft die op chassis staan en kan je pas dag erna ritje afmaken). Wij houden dat zelf bij: breng je de container naar Rotterdam of buitenland: per auto: hoeveel uur en km? En hoeveel is de opbrengst daarvoor? Kijken hoeveel ritjes (containers) per auto. Het zou wel eens kunnen dat een klant ons wil laten betalen omdat we te laat zijn. Stel wij zijn op tijd vertrokken met een opdracht dan gaan we niet betalen. Als er bijvoorbeeld een container nodig is om 11 in Rotterdam, het is een half uur rijden, dus dan zijn we 1,5 uur van tevoren bij een terminal (1 uur turnaorund time voor de terminal); als we dan vertraging hebben door wachttijden bij de terminal geven we dat aan dus dan betalen we niet. Alleen als wij te laat zijn begonnen dan kunnen we ze wel betalen.

12. Do you charge shippers for the waiting times at terminal gates and if yes; how?

Die extra kosten zitten erin verrekend, maar we belasten ze dus niet per container. Stel het gaat sneller heb je juist een voordeel. Soms juist hele onproductieve dagen, dan maak je daar verlies op.

13. How do you think these waiting times could be mitigated?

Met het bestuur van AZV, de deelmarkt TLN van zeecontainer vervoerders, kijken we naar mogelijkheden. Voor tijdslot terminals zijn we kijken of volle containers altijd ingeleverd kunnen worden. Want een terminal is vaak ingedeeld in blokken, waar importcontainer staat heb je geen invloed op (bv drukte bij de kraan). Over het algemeen zijn er kranen die het minder druk hebben; hoe kan je dan je volle container daar alvast inleveren? Nu moet je daarvoor ook tijdslot reserveren; maar dat is niet handig. Als het druk is op terminal: dan kan je toch je chassis leeg maken en kan je door naar andere terminal. Verder heeft de ECT een app: om inzichtelijk te maken waar het druk is zodat je kan kiezen toch andere terminal; dan gaan je nu naar andere stackposities. Ik ben een voorstander van tijdslot terminals (ook al is het planning technisch moeilijker); het is wel eerlijker; voorspelbaardere keten en helpt voor spreiding. De Euromax en ECT terminals hebben geen tijdsloten: kom wanneer je wil. Nu zitten de RWG tijdsloten wel vol: dan boeken we morgen; vandaag mijden we die terminal en doen we de containers vandaag zonder tijdsloten terminals. Of als het 's morgens minder druk is: alle RWG's inleveren: het dwingt vanzelf naar rustigere tijdsloten. Als het zo is dat het de hele week vol zit: dan gaan we met klant in gesprek: dan mogelijk 's nachts rijden: kan ik ze dan 's nachts lossen? Of bijvoorbeeld extra kosten? Dat we wachten voordat de klanten ze willen lossen. Dus terminal tijdsloten zijn een middel voor afdwingen spreiding. Bij tijdslot terminals (de automatische) is er net zoveel capaciteit 's nachts, bij ECT 's nachts rijden veel minder mensen. Dus die moeten ook aanpassen (de handmatig)

14. Does your company perform night-time container transport at this moment and why?

Niet echt maar soms in het weekend als oplossing als het druk is. Dan zegt een klant ik ga wel zaterdag werken of zondag. In het weekend zijn de terminals ook rustiger. Je vindt niet zomaar makkelijk 's nachts chauffeurs. Want dat moet dan hele week (want die chauffeurs kunnen niet en nacht en overdag doen). Dat moet financieel haalbaar: permanent doen: genoeg aanbod van klanten hebben, die dan ook 's nachts open moeten zijn.

15. Who chooses the time scheduling of container distribution?

De laad los tijdplanning wordt bepaald door de klant (kan fixed tijd of dag zijn). Uiteindelijk de precieze tijd van afhalen en inleveren bij de terminal bepaalt onze planning (terminal bezoeken); wij willen echt onze efficiëntie winnen; maar er zitten ook restricties aan; containers worden bijvoorbeeld maandag al geladen maar pas voor de boot voor weekend op het RWG. Dan hebben we de hele week om weg te brengen, en wachten we tot je een terugritje hebt zodat je altijd 2 ritjes maakt naar de terminal. Wel voor zorgen dat alle containers voor vrijdag weg zijn, wanneer de boot vertrekt.

16. How does night-time container transport influence your processes?
17. Do you think night-time transport (would) add/reduce costs for you and why?

Wij zien dat het in het weekend bijvoorbeeld sneller gaat dan door de week. Maar niet alle depots zijn open. Dus welke klussen heb je dus kan het wel echt in het weekend? In nacht ook kijken of het geschikt is? Wel veel efficientie. Maar er zijn ook nadelen: loonkosten en dus permanente chauffeurs voor de nacht zijn nodig. Weekend is makkelijker want kan iets flexibeler. 's Nachts is het wel efficienter dus als alles kan en genoeg aanbod (containers) van klanten, dan is het wel beter om te doen.

18. What are the constraints of night-time container transport?

De klanten die niet 24 uur open zijn. Als dat zo zou zijn, zouden wij ook sowieso mee gaan in die tijden, wij zijn namelijk als vervoerder een dienstverlenend bedrijf.

19. How do you think these constraints could be relaxed, apart from your own hub?

Beter praten direct met klant. Dus vragen of ze toch open willen.

20. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?

Een plek bij de ontvanger zou het beste zijn. Wij werken vaak met een avondtaak, dan gaan ze bijvoorbeeld pas om 7 uur stoppen en houden ze heftruck chauffeur die containers af en op zet nog wat langer bij een klant. Dat werkt het beste.

21. What would be reasons for you to (not) use a hub with extended opening hours?

In principe kunnen wij zelf die beslissing maken maar zou het wel altijd in overleg doen met klanten. Nu hebben ze ook geen probleem met wanneer wij die container ophalen vanaf de terminal. Zeker klanten waarbij wij niet de huisvervoerder zijn maakt het vast niet uit.

22. Do you think using a hub with extended opening hours would add/reduce costs for you and why?

Dat ligt aan alle kosten en hoe snel het duurt.

23. Would you as a trucking company want to perform both the night-time distribution between the terminal and the hub and the day-time distribution between the hub and the receiver or only one of the legs and then let another (contract with a) carrier settle the other leg and why?

Weet ik niet precies. Denk niet dat samenwerken met 1 container heel snel te verwezenlijken is met groep vervoerders. Eerder dat wij zelf een eigen hub creëren. Daar hebben wij genoeg containers voor en dan houden wij het in eigen beheer. En het moet nog veilig zijn ook (containers kunnen hoge waarde hebben). De klant heeft ook echt een deal met ons voor veiligheid. Wij huren heel veel chassis (zelf hebben we er 20), we huren er elke dag wel 100. We hebben meer chassis dan auto's. Sommige op 3 jaar basis. Een chassis-exchange zou goed kunnen maar het moet wel een veilige plaats zijn.

24. What are the constraints of a hub with extended opening hours?

De veiligheid, de extra kosten door toevoegen van een stop. Eerlijk gezegd geloof ik er voor ons vervoer niet in omdat we op zoveel korte afstanden zitten. En het kost je toch meer een half uur om om te rijden en container te lossen en laden; dus puur naar ons werk (in Rotterdamse haven). Wij komen heel vaak de hele dag door bij terminals en in de ochtend is het redelijk rustig, pas in de middag wordt het echt druk (2/3 uur – 6/7 uur; echt drukke tijden). Voor een chassis-exchange: door diverse gebruikers: problemen met goed chassis neergezet, slecht chassis terug. Wat als iemand anders jouw chassis schade rijdt?

25. How do you think these constraints could be relaxed?

Als je zelf het bij je eigen chassis houdt: het zou kunnen. Als je dat snel doet (binnen 20 minuten weg) en omrijden niet van toepassen; rendabel kunnen worden. Heel makkelijk plat geslagen: 11% terminaltijd meer, dat is heel veel dus 1 uur en 10 min als je van een uur uit gaat. Bij een extra stop dan zou je er een half uur bij krijgen. Je zou de tijd voor het gebruiken van een hub lager moeten krijgen dan de wachttijd bij terminals. Dan zou het interressant worden.

26. Do you think you would possibly invest a hub with extended opening hours and if yes; how?

Als het zou lonen; dus als het rendabeler zou werken; dan zouden we wel investeren. In de toekomst willen we toch een bepaalde locatie in Rotterdam (gebruiken nu wat terreinen van ander om wat chassis neerzetten). Straks elektrische vrachtwagens: die hebben een locatie en terrein nodig: dan stuk aannemelijker (financieel) om ook heftruck neer te zetten. Ergens komt er een omslagpunt (misschien in de toekomst bij meer wachttijd). Mogelijk dat de klant een locatie heeft die 24 uur open is: meest kost-efficiënt, als je laad los adressen dat hebben. Ik zelf denk niet dat we allemaal gemaakt zijn om in de nacht te werken. Eerder in het weekend. Het moet echt noodzakelijk zijn (zoals alle tijdsloten vol bij RWG). Bijvoorbeeld één vervoerder zou het nacht vervoer kunnen doen.

G.1.3. Carrier C

1. What kind of carrier are you (talking about distance and type of transport)?

We vervoeren zeecontainers (deep sea containers). Zijn gespecialiseerd in Benelux/Europa. Ons zwaartepunt ligt in Nederland en België. 90% van de containers blijven in Nederland en België.

2. What are the distances that you transport containers to and from the terminals?

Rotterdam komt wel eens voor (DC), maar niet heel veel omrijden van terminal. Vaak laden/lossen.

3. How many trucks does your company have?

125 eigen trucks ongeveer, 15 charters. Allemaal eigen chassis, dus 150/160 chassis.

4. How does the process of planning the transport work?
5. How do you interact with shippers, receivers, freight forwarders?

Het begint met afspreken met bepaalde klant rijden (met wie zaken doen). Daarna worden de orders verstuurd (telefonisch afgestemd); vervolgens per email naar ons verstuurd. We hebben contact met DCs en terminals voor het voormelden en tijdsloten om bezoek aan te kondigen, via Portbase of eigen site. DC's warehouses in opdracht van klanten zijn onze klanten. Een expediteur zit er vaak tussen.

6. Who makes decisions about the time window of container pick-up/delivery and how?

De klant geeft aan wat de voorkeur is en als haalbaar gaan wij dat uitvoeren. Het tijdsvenster is elke keer verschillend (ochtend/middag/uur/flexibel).
7. How do you set-up your contracts with shippers?

Met alle klanten hebben we tarieven voor 1 jaar (soms korter/langer); geen aantallen/bestellingen in de contracten. De prijs per container ligt aan een combinatie van plaats, tijd, bestemming, km. We gebruiken ook wel eens de spotmarkt (email, site, telefoontjes). Bij voorkeur nemen we samen met collega's containers van elkaar over, in plaats van op de markt (zoals boekingsbureau's als U-turn).

Questions on waiting times at container terminals:

9. Do you perceive waiting times at terminal gates' and how?

Ja die merken wij zeker. We moeten vaak wachten.

10. What do you think is the reason for these waiting times?

Terminals hebben het te druk met boten lossen, intern overrijden, stacks, andere modaliteiten. Wij moeten vaak tijdsloten aanvragen bij terminals dus we kunnen niet allemaal tegelijk komen.

11. What are the consequences of these waiting times for you?

Klagende chauffeurs, ook sommigen die er mee stoppen. Ook komen we door de wachttijden te laat bij de klant aan. Extra kosten voor wachtten die niemand wil betalen. Rijtijd overtredingen, als agent je aanhoudt en je bent als chauffeur al te lang aan het rijden door de wachttijden. Ook hebben we hierdoor een beperkte capaciteit (omdat we minder containers kunnen vervoeren). Soms moet je langer wachten bij tijdslot klant als je te laat bent aangekomen, omdat ze al begonnen zijn een andere container uit te laden, dus moet je wachten tot je aan de beurt bent. Soms willen ze je niet meer helpen. Soms hoor je niks, omdat ze ook wel weten hoe het er aan toe gaat.

12. Do you charge shippers for the waiting times at terminal gates and if yes; how?

We proberen het wel maar niet al onze klanten zijn daar even toegankelijk toe.

13. How do you think these waiting times could be mitigated?

Meer terminal capaciteit. Rederijen moeten beter op tijd komen en duidelijker zijn in calls die ze maken. Dat geeft nu namelijk veel problemen, ze zijn vaak te laat. Je mag het niet inleveren waar je wil en moet je container weer op een andere plek van de rederij inleveren dan waar je wil.

14. Does your company perform night-time container transport at this moment and why?

Nee want klanten willen goederen tussen 7 uur 's ochtend en 3 uur 's middags. We beginnen wel vroeg en gaan tot laat door.

15. Who chooses the time scheduling of container distribution?

Wij kunnen kiezen wanneer we containers ophalen bij de terminals, maar klanten bepalen de tijd dat we bij hen moeten zijn.

16. How does night-time container transport influence your processes?
17. Do you think night-time transport (would) add/reduce costs for you and why?

Nacht toeslag voor chauffeurs kost geld en de totale organisatie is er op dit moment niet op ingericht, dus nu zou het meer geld kosten.

18. What are the constraints of night-time container transport?

Terminals zijn vaak niet toegankelijk 's nachts. Ze hebben maar 1 echte klant; dat zijn de rederijen. Ook zijn de klanten niet open. Ook moet je structureel chauffeurs hebben die 's nachts willen werken (nu al moeite om mensen overdag te vinden. En iemand die de chauffeur moet helpen. Klant moet iedere avond open zijn voor minstens 3, 4 of 5 containers. Structureel moeten ze dat dan willen. Want onregelmatig container vervoer kan niet voor de nacht.

19. How do you think these constraints could be relaxed?

Terminals moeten meewerken door snel te zijn 's snachts. Maar vooral moeten we de containers 's nachts ergens kunnen weg brengen, dus de klanten ook 's nachts open.

20. What would be reasons for you to (not) use a hub with extended opening hours?

Kosten. 's Nachts is gedoe. Het moet echt een goede business case zijn.

21. Do you think using a hub with extended opening hours would add/reduce costs for you and why?

Ik denk nu nog dat het meer kosten zijn. Dat moet eerst een goede business case worden.

22. Would you as a trucking company want to perform both the night-time distribution between the terminal and the hub and the day-time distribution between the hub and the receiver or only one of the legs and then let another (contract with a) carrier settle the other leg and why?

Alleen overdag. Omdat dat makkelijker is.

23. What are the constraints of a hub with extended opening hours?

Vooral kosten dus. Het lijkt me erg duur.

24. How do you think these constraints could be relaxed?

Bijvoorbeeld als er bepaalde containers zijn die echt optijd moeten zijn. Het feit dat je meer productiviteit hebt door een hub is wel positief. Het zou echt kosten besparend moeten zijn.

G.1.4. Carrier D

1. What kind of carrier are you (talking about distance and type of transport)?

We doen lang en kort vervoer (buitenland en richting Hamburg, Basel, Parijs: 85%, 2%: Portugal). We hebben ook lokale auto's (60%): in de buurt Rotterdam of Antwerpen, 50% Rotterdam en 10% Antwerpen.
2. How many trucks does your company have?

80 trucks.

3. How does the process of planning the transport work?
4. How do you interact with shippers, receivers, freight forwarders?

We hebben vaste opdrachtgevers. Expediteurs en directe klanten, carrier-chauffeurs (bulk). Klanten mailen ons, Klanten bellen vaak. We hebben ook contact met andere vervoerders. We gebruiken geen U-turn (dat is soort Marktplaats voor container vervoer).

5. Who makes decisions about the time window of container pick-up/delivery and how?

De klant vraagt of we plaats en datum en tijd kunnen zijn.

6. How do you set-up your contracts with shippers?

We hebben langdurige klanten met vaste prijsafspraken (jaarlijks bijgesteld). De prijzen zijn opgesteld op basis van kilometers.

Questions on waiting times at container terminals:

7. Do you perceive waiting times at terminal gates' and how?

Ja die zijn er. De chauffeur bedient boardcomputer (daarin komt opdracht) en verantwoord die zn eigen tijd. Het systeem bericht meteen de klant als er ergens te lang staan. Bij de RWG en Progeco zijn heel vaak wachttijden.

8. What do you think is the reason for these waiting times?

Bij Procego; met de strategie van personeel is iets mis mee. In het begin ging het goed: je moet een tijdslot aanvragen, maar nu sta je alsnog 1,5 uur te wachten. Bij de RWG: als je tijdslot hebt, kan je wel naar binnen. Bij andere terminals is het overal wel gemiddeld.

9. What are the consequences of these waiting times for you?

Wij kunnen hierdoor minder containers per dag vervoeren: ziet de planner natuurlijk: geen vaste waardes voor wachttijden, en met tijdsloten helemaal lastig. Als wij te laat aankomen bij klanten zijn er af en toe adressen waar wij moeten betalen (maar na 2 keer betalen is het klaar voor ons; dan gaan wij daar niet meer naartoe).

10. Do you charge shippers for the waiting times at terminal gates and if yes; how?

Ze mogen zelf kiezen of ze een vaste congestie toeslag per container betalen of met het teller systeem werken. Bij die tweede werkt het zo dat als we er te lang staan geven we het door (systeem teller); na een bepaalde tijd krijgen klanten een seintje en dan moeten ze dat betalen (bij bijvoorbeeld 5 min zitten we van laat maar zitten, alle wachtkosten dan): de meeste kiest dit laatste.

11. How do you think these waiting times could be mitigated?

De terminals moeten hun capaciteit verhogen.
12. Does your company perform night-time container transport at this moment and why?

Nee, wij werken op normale tijden.

13. Who chooses the time scheduling of container distribution?

De klant zegt wanneer we er moeten zijn. Maar het maakt ze niet uit wat we daarvoor doen.

14. How does night-time container transport influence your processes?
15. Do you think night-time transport (would) add/reduce costs for you and why?

Verhoogde efficiëntie in de nacht zou kunnen maar ligt aan het adres. Het is een rekensommetje wat je per adres zou moeten bekijken. Bijvoorbeeld ook kijken hoeveel containers zou je er dan doen?

16. What are the constraints of night-time container transport?

Ik vind dat chauffeurs 's nachts moeten slapen. Dat is ook makkelijker voor de rij en rust tijden regelingen en de indeling die je moet maken. Maar vooral het feit dat de klanten niet open zijn is een reden dat we het niet doen.

17. How do you think these constraints could be relaxed, apart from your own hub?

Stel de klanten zouden wel 's nachts open zijn, dan kijken we naar het totale plaatje. Op dit moment is bijna alles van tussen 08.00 en 15.00 open.

18. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?

Bij een chassis-exchange is er wel de vraag; wie is er verantwoordelijk voor de chassis (als je verandert per vervoerder wie het andere gedeelte doet).

19. What would be reasons for you to (not) use a hub with extended opening hours?

Voor ons zou een hub moeilijk zijn door de AEO status (van de douane) en de veiligheid van containers. En de wachttijden bij de terminal zouden echt hoog moeten zijn.

20. What are the constraints of a hub with extended opening hours?

De kosten. Die zouden lager moeten zijn dan de kosten van wachte nvoor terminals.

21. How do you think these constraints could be relaxed?

Klanten die van 08.00 tot 15.00 open zijn zouden bijvoorbeeld kunnen meebetalen aan het gebruik van een hub als de containers daardoor minder vaak te laat zouden komen. En in de toekomst als er elektrische vrachtwagens komen zou een chassis-exchange nog beter passen omdat er toch parkings nodig zijn.

G.2. Receivers

G.2.1. Receiver A

General questions about company and processes:

1. What kind of company are you?

We hebben 2 locaties waar we containers ontvangen (De Meern in Utrecht en Barendrecht bij Rotterdam). We regelen ook het transport vanaf de haven naar onze locaties (99% gaat naar onze locaties). 1% gaat direct naar onze klanten (dus 1% expediteur). Onze klanten zijn groente en fruit importeurs. We regelen het transport met transporteurs/charters.

- We receive containers at 2 locations.
- We arrange the transport between port and our locations with trucking companies
- Our customers are fruit and vegetables import companies
- In 99%: containers to our locations, then to our customers (we are receivers)
- In 1%: containers straight to customer (we are only a freight forwarder)

2. At what kind of location do you receive containers (DC/depot/manufacturer)?

Distributiecentra

- Distribution centres

3. Where is this location (close/medium/far away)?

1 dicht bij in Barendrecht (Ridderkerk), 1 ver weg in Utrecht (De Meern)

- 1 close to Rotterdam: in Ridderkerk
- 1 further away: in De Meern (Utrecht)

4. How many containers do you receive from and send to the terminals in the port of Rotterdam per day on average?

Dat is er heel erg seizoensgebonden. Nu bijvoorbeeld kunnen het er maar 10 op een dag zijn, maar het kunnen er ook 40 zijn. Ons record is 80 containers op 1 dag. Dit jaar t/m oktober hebben we voor 4.550 containers het transport verzorgd vanaf de havens Rotterdam en Antwerpen. Verdeeld over ca. 650 uit Antwerpen en 3.900 uit Rotterdam.

- Different per season. Now 10 per day, but can be 40 or even 80 containers per day.

5. How does the process work of ordering and planning the transportation of a container?

We proberen een week van tevoren de containers te verdelen over de verschillende vervoerders. Hierbij kijken we naar aankomsttijden van de boten en beschikbaarheid van vervoerders. De vervoerder plant 's middags de containers voor de volgende dag in – in overleg met ons. Hier wordt rekening gehouden met de lostijden van de boten, welke containers zijn 's nachts te lossen en ook weer 's nachts leeg retour in te leveren, welke containers hebben prioriteit, lossende boten, KCB-tijden etc.

- We try to divide the containers a week before over all the carriers by looking at arrivals of container ships and the price, availability and flexibility of carriers.
- Carrier plans transport for next day, with us. Looking at arrivals of ships, which containers can be transported at night and also delivered at an empty depot again at night, which containers have priority and inspection times

6. How do you interact with carriers, freight forwarders and other actors?

Zoals eerder beschreven plant de vervoerder in overleg met ons de containers in voor de volgende dag. Dit gaat zowel via de mail als telefoon. 's Middags geven wij als logistiek dienstverlener een planning door aan onze klanten voor de volgende dag, inclusief KCB-tijden. Bijvoorbeeld: containers a b worden morgen 1e werk geleverd, c d volgen in de 2e rit – alle 4 hebben keuring om 13.00H, containers e f zijn van een lossende boot dus hiervan is nog geen tijd beschikbaar. Tijdsloten plant de vervoerder zelf in en dit koppelen zij terug aan ons. Op de dag zelf is er continu overleg over de planning. Klanten willen namelijk ook op de hoogte gehouden worden. Natuurlijk kunnen we zelf op de diverse websites van de terminals in de gaten houden welke container van boord is of vertrokken is van de terminal maar het is belangrijk om de fase ervóór te weten. Bijvoorbeeld: over een uur is er een auto plat op de terminal om container x op te gaan zetten. Met die informatie kun je klanten eerder informeren en een planning doorgeven.

- Carriers plan the transport with us via mail and phone. In the afternoon we give the planning to our customers (import companies) including inspection times, like: containers a and b are delivered at our location in the first shift, then 2 in next shift, inspection are all at 13h.
- Timeslots at terminals are planned by the carriers themselves and they report that to us.
- During the day there is a continuous reporting of the planning from carriers to us, so we can report to customers what is happening with their containers
- On websites from terminals we can see which containers are on board or at the terminal

7. How are contracts with carriers or freight forwarders created?

We werken al jaren met vaste vervoerders. Uiteraard valt er weleens eentje af of komt er eentje bij, maar we werken niet eenmalig met een onbekende vervoerder. Dat vind ik ook een risico. Jaarlijks worden de tarieven opnieuw besproken.

- We work with regular carriers for years, not with unknown carriers (that's a risk)
- The rates for carriers are renegotiated every year

8. What is your role in the time scheduling of container pick-up/delivery?

Aanlevertijden bespreken we met de klanten, zodat we weten welke containers prioriteit hebben en vervolgens bespreken we met de vervoerder(s) wat mogelijk is. Dit gebeurt ook andersom, dus eerst met de vervoerder bespreken wat mogelijk is en vervolgens de klant een voorstel doen. We werken met zeer flexibele vervoerders. We verwachten eigenlijk van een vervoerder dat wanneer er op de dag zelf een container van boord komt, hij deze binnen 2 uur kan gaan opzetten. Het komt ook voor dat we containers moeten omplannen om de container sneller binnen te krijgen. Hiermee bedoel ik dat we een container annuleren bij de ene vervoerder omdat hij geen auto beschikbaar heeft en vervolgens onderbrengen bij een andere vervoerder die wel ruimte heeft in zijn planning.

- We first discuss delivery times with customers so we know which container has priority and then discuss with carriers what is possible (and also other way around)
- We work with flexible carriers, that they can receive a container at a terminal within 2 hours
- Sometimes we have to reschedule containers to another carrier to receive them faster

9. What are your requests about the time schedule and why?

Bij voorkeur zoveel mogelijk containers om 7.00H omdat het dan nog niet druk is met verladingen. Daarnaast is het ook een verzoek van de klanten, omdat de container dan gelijk door de keurmeester kan worden geïnspecteerd en vervolgens de KCB de container kan keuren en de goederen vrijgemaakt kunnen worden (inklaren) en er verladen kan worden. We snappen ook dat een vervoerder niet alles 1e werk kan aanleveren en hij meerdere ritten per dag wil rijden met 1 auto. Daarom stemmen we af welke en hoeveel containers er in de 1e rit geleverd moeten worden, welke in de 2e en evt 3e rit. Op onze locatie wordt er ook 's nachts gelost – om de drukte op de terminals te vermijden. In De Meern mogen containers tot 16.00H geleverd worden. In Ridderkerk is het streven het gros voor 13.00H binnen te hebben. Uiteraard lukt dat niet altijd (mede door lossende boten).

- Preferably as many containers at 7h because it is not busy yet at our locations.
- Also customers would like the containers early so the inspection can be done and products can be prepared for sending to customers
- We understand that carrier can not do everything in first trip (but makes tours during the day)
- Thus we agree on how many containers are delivered in first trip, in second and possibly third
- At our site in Ridderk (close to Rotterdam), containers can be unloaded at night to avoid congestion at terminals. We aim to have most of containers in before 13h (not always possible)
- At our site in De Meern, containers can be delivered until 16h.

Questions on waiting times at container terminals:
10. Do carriers sometimes arrive too late with the containers at your facility?

Uiteraard! Als de levering van 7.00H niet op tijd is, dan kan dat doordat een pincode niet klopt, de DEN-regeling of T1 document niet goed is doorgelopen naar de terminal of simpelweg omdat de chauffeur zich verslapen heeft. Het kan ook dat de boot vertraging heeft gehad met lossen of dat de terminal dicht is gegaan wegens de wind. Als er 's nachts gelost wordt, is de planner van de vervoerder ook 's nachts aan het werk om de chauffeurs te begeleiden. Bij onze eigen containers loopt de 1e rit eigenlijk altijd goed, daarna is het afhankelijk van de drukte op de terminals, op tijd zijn voor de tijdsloten, niet in de pauzes aankomen van terminals, geen wachttijden hebben bij de inleverdepots omdat ze vol zitten etc.

- Yes! If the delivery of 7h is not on time; because of wrong pincode, the DEN arrangement, T1 document did not go through properly or truck driver overslept
- Or the ship was delayed with (un)loading or the terminal closed because of the wind.
- If the transport is done at night, the planner of the driver is also supervising at night
- With our containers the 1st trip goes well, after that it depends on how busy the terminals are, if carriers are on time for their time slots, if they don't arrive during breaks and if there are no waiting times at empty depots (because they are full)

11. Do you know the reason behind late arrivals of containers? If yes; please explain

Zie ook punt 7. Ik ben van mening dat de wachttijden vooral ontstaan bij de inleverdepots en op de terminals. Een enkele keer komt het door onszelf, omdat containers dan te lang op onze locatie moeten wachten om gelost te kunnen worden.

- Mainly because of waiting times at terminals and empty depots

12. Do you have to pay carriers/freight forwarders for the waiting times at container terminals?

Meestal nemen de vervoerders die voor hun rekening. Als het echt extreem is, vraagt de vervoerder of hij de auto moet laten wachten op de terminal of dat hij hem weg kan halen. Dit vragen we na bij de klant en als de klant wil dat de auto blijft wachten, betaalt hij de wachtkosten. Ook als we vooraf weten dat het erg druk is op de terminal overleggen we eerst met de klant voordat we een auto sturen. Dan zijn de kosten ook voor de klant.

- Usually the carriers pay for waiting costs
- If it's extreme, the carrier will asks if he has to wait on terminal or go away, we will ask it to the customer and if he says stay, then the customer will pay the waiting costs
- Also if we know in advance that it will be busy, we first discuss with the customer

13. Are there consequences for carriers for arriving too late at your facility and if yes, what?

Nee, zolang het buiten hun schuld is. Als ze regelmatig te laat aankomen om onduidelijke redenen dan rijden we (tijdelijk) niet meer met ze. Het is voor ons van belang dat er open en eerlijk wordt gecommuniceerd. De informatie die we van de vervoerder krijgen, communiceren wij vervolgens weer door naar onze klanten. Als die informatie achteraf niet blijkt te kloppen, kan dit verstrekkende gevolgen hebben voor de klant – en dus voor ons.

14. What are the consequences of these late arrivals for all your processes?

In een extreem geval kan het zijn dat de klant een dag later pas beschikking heeft tot zijn container. Aan de hand van de planning die een dag van tevoren wordt gemaakt, wordt de KCB aangevraagd. Als die mensen komen en de container is niet aanwezig, wordt er een "vergeefse reis" belast. Dat is ongeveer € 150. Het geld is nog niet het ergste, want er moet een nieuwe tijd worden aangevraagd. Het kan zijn dat de KCB later op de dag geen tijd meer vrij heeft en dan kan er niet gekeurd worden, niet ingeklaard worden en dus ook niet worden verladen. Het kan zijn dat onze klant een leveringsverplichting heeft aan zijn klant en vervolgens handel moet gaan bijkopen bij concurrenten om de levering alsnog te kunnen garanderen. Wat ook kan, is dat de containers pas laat aankomen waardoor er niet voldoende capaciteit is in de loods om de containers te lossen. Als voorbeeld: de heftruckchauffeurs werken van 7.00-16.00H. Daarna lopen er nog maar een paar heftruckchauffeurs tot 18.00-20.00H. Die zijn vooral druk met het laden van auto's. Als er dan wachturen ontstaan, wijzen we deze af – aangezien de vervoerder zelf te laat aankomt op onze locatie. Daarnaast zit er in de containers fruit – bederfelijke goederen. Als een container op de boot al vertraging heeft opgelopen is het cruciaal dat de container zsm wordt geleverd. Omdat de wij in het laatste stukje van de keten zitten, hebben wij met de meeste druk te maken. Het heeft namelijk geen zin om de kapitein van een schip te bellen om het schip sneller te doen varen, het heeft ook geen zin om de terminal te bellen en te vragen het schip eerder te gaan lossen of onze containers als eerste van boord te halen. Waar ze wel invloed op kunnen uitoefenen (en dus ook doen) is hun logistiek dienstverlener (wij dus) onder druk te zetten. Vervolgens zetten wij onze vervoerder weer onder druk.

15. Do you incur costs by paying an unloading crew while the container is not yet there (due to waiting times), and if so, approximately how often?

Dat komt eigenlijk niet voor. In De Meern zijn we geopend tot 20.00H. Omdat we de uiterste aanlevertijd op 16.00H hebben staan, gebeurt het bijna niet dat containers na 18.00H aankomen. In Ridderkerk zijn we geopend tot 18.00H. Als de loods naar huis is en we zijn nog wel op kantoor, dan laten we de chauffeur zelf lossen. Zijn we naar huis? Dan moeten ze blijven staan tot de volgende dag.

16. How do you think these waiting times could be mitigated?

Beter inspelen op de drukte. Als er 3 grote boten op 1 terminal aankomen, dan weet je op voorhand al dat dit wachttijden gaat opleveren. Op maandagochtend is het ook altijd een drama. Als je dit van tevoren weet, zou je extra mensen moeten inzetten. Daarnaast zijn er ook veel wachttijden bij de inleverdepots. Mede doordat ze vol zitten. Wij proberen daarom dus veel 's nachts te lossen. Het probleem is echter dat niet alle inleverdepots 's nachts geopend zijn. Wanneer we de rederij vragen om het "leeg retour" om te boeken, moet daar vaak geld voor betaald worden, circa € 130. Die kosten wil niemand betalen en kan de container dus niet 's nachts uitgehaald worden. Als rederijen hierin beter willen meedenken, zou het de drukte op te dag kunnen verlichten. Als het druk is op de terminal, wordt er vanuit de desbetreffende terminal een automatische

mail gestuurd met het verzoek niet naar de terminal te komen. Omdat er druk zit op AGF-containers is dit meestal geen optie en moeten we gewoon in de rij gaan staan. Ik vind dit persoonlijk geen goede reclame – vervoerders vragen niet naar de terminal te komen. Ik zou zorgen dat de achterstand wordt ingelopen en er geen wachttijden ontstaan ipv vervoerders te verzoeken niet te komen. Men dacht dat tijdsloten een oplossing zou zijn, maar dat blijkt het ook niet. Betere planning qua boten / terminals, personele bezetting en 24-uurs leveringen zouden de wachttijden moeten doen krimpen.

17. Does your company accept container at night and if yes/no; why?

Op onze locatie in Ridderkerk wel, De Meern (nog) niet. Dit is afhankelijk van de wensen van de klant. We hebben 1 klant die eist dat hun kwaliteitscontroleur aanwezig is op het moment dat de container arriveert. Dan is 's nachts lossen geen optie. Daarnaast zijn er een aantal fruitsoorten die simpelweg niet in de nacht gelost kunnen worden (druiven moeten op nul graden / de temperatuur van de expeditieruimte is 8 graden dus dat is te warm) – (voor avocado-containers moet voorafgaand aan het lossen een gasmeting gedaan worden, dus deze containers kunnen ook niet 's nachts gelost worden). Deze uitzonderingen zijn alleen mogelijk als er besloten wordt dat de loods 24/7 gaat werken.

18. What is your role in the time scheduling (day/night) of container transport?

Wij bepalen wat er 's nachts gelost mag worden en niet iedere vervoerder mag dat bij ons. Het heeft te maken met vertrouwen, want in theorie zou er bijvoorbeeld gestolen kunnen worden. Daarnaast hebben we goede afspraken gemaakt hoe om te gaan calamiteiten, zoals: temperatuur te warm van het fruit, waterschade in de container, fruit gestikt door gesloten ventilatieluikje en pallet(s) die vallen tijdens het lossen. Bij iedere container moet vooraf gecontroleerd worden of het ventilatieluik open staat. In het eerste geval moet de container worden afgekoppeld omdat er een surveyor naar zal moeten kijken en die willen fysiek de container zien en de koeler uitlezen. Wat betreft waterschade moet de chauffeur foto's en een filmpje maken. En ook de container afkoppelen voor inspectie door de surveyor. Container met gestikt fruit ook afkoppelen. Mochten er pallets vallen tijdens het lossen, of vallen bij het openen van de containers, dan dient de chauffeur foto's te maken zodat we 's ochtends de klant kunnen informeren.

19. Do you think being open at night adds/reduces costs/benefits for you and why?

Minder kosten, aangezien de vervoerders zelf lossen en wij niet aanwezig zijn in de nacht. 's Nachts lossen heeft alleen maar voordelen voor ons, alsook voor de vervoerder. In de nacht zijn er geen wachttijden dus de vervoerder kan meer ritten in de nacht rijden dan overdag. Voor ons heeft het als voordeel dat de vervoerders zelf lossen, dus als wij 's ochtends beginnen, staan de eerste containers al op de vloer. Doordat containers in de nacht worden gelost, ontlast dat de drukte op de dag. Tarieven voor 's nachts of overdag lossen voor vervoerders zijn hetzelfde.

20. Do your carriers (sometimes) use some sort of hub/chassis exchange somewhere between the terminal and you where they can bring containers at night (without waiting times) and then bring them to you during the day (so they are more on time) ; and if so how exactly?

Dat gebeurt weleens als de containers niet 's nachts leeg retour kunnen worden ingeleverd. Dan wisselt de chauffeur van chassis zodat hij toch kan doorrijden. Nadeel is wel dat 's ochtends eerst de chassis leeg gemaakt moeten worden voordat er nieuwe containers kunnen worden opgezet. Daarnaast wil een vervoerder nog weleens 's avonds een container opzetten, gaan slapen en dan 's ochtends gelijk voor de deur staan. "Voorladen", wat je beschrijft wordt niet veel gedaan omdat de temperatuur niet gereguleerd kan worden als de container op het chassis staat.

21. Do you think using a hub with extended opening hours would add/reduce costs/benefits for you and why?

Meer kosten, geen voordelen. Je moet dan extra chassis gaan aanschaffen om dit mogelijk te maken. Daarnaast zit je met het temperatuur probleem. Dan zou je daar stekkers moeten gaan maken waar de container aan gekoppeld wordt zodat de container gekoeld (of verwarmd) blijft. Je verschuift dan alleen het probleem. Als je als vervoerder als je materiaal "vol" hebt staan en alle containers worden om 7.00H gelost, dan wordt de drukte alleen maar groter bij de inleverdepots, omdat er minder spreiding is. Als voorbeeld: op maandagochtend staat iedereen om 5.00H op de terminal om containers op te zetten, om 6.00H rijden ze weg, om 7.00H staan ze bij onze loods. Om 8.00H rijden ze naar het inleverdepot en om 9.00H staan ze daar, om 10.00H staan ze allemaal weer terug op de terminal voor de volgende container en dan is het chaos. De oplossing is naar een 24-uurs economie gaan zodat er meer spreiding is. Loodsen en leeg-retour-depots moeten 24/7 open zijn zodat er ook in de nacht gewerkt kan worden. Terminals zijn gelukkig als 24/7 open. En als er wachttijden bij de

inleverdepots dreigen te ontstaan, het depot wijzigen.

22. Would you pay more/less for transport of containers (to use a hub) so that containers are delivered more often on time?

I do not think we would do that.

G.2.2. Receiver B

General questions about company and processes:

1. What kind of company are you?

Wij zijn een importeur en exporteur van exotische groente en fruit (zoals mango, avocado, asperges). Die halen we allemaal hierheen. Hier rijpen we de groente en fruit en maken we ze klaar voor de winkel. Het rijpproces duurt ongeveer 5 dagen. Wij zijn hierin de grootste van Europa. We hebben 15 rijpcellen op onze hoofd-locatie en een aantal extern. Wij doen 5.000 zeecontainers per jaar. 85% van de containers komt ongeveer van de Rotterdam Maasvlakte. Het rijpproces duurt 5 dagen, maar eerst zijn er nog keuringen en veel verplichtingen dus er komen nog een aantal dagen bij dat het groente en fruit bij ons is (minimaal een buffer van een dag of 3).

- Importer and exporter of exotic fruits and vegetables
- At our location they ripe (takes about 5 days). We also have inspections and other obligations.
- We are the largest of Europe for this
- We get 5.000 sea containers per year, from which around 85% from the Port of Rotterdam

2. At what kind of location do you receive containers (DC/depot/manufacturer)?

We hebben 1 hoofd-locatie (nu eigenlijk 4 of 5) maar het streven is 1. Daar ontvangen we alles, overslaan, produceren en rijpen we de producten. Deze locatie is ongeveer 700.000 vierkante meter. We hebben nu nog een B locatie (want mango en avocado's gescheiden), omdat we te hard zijn gegroeid.

- A few locations because we grew too fast, but we want 1 location.

3. Where is this location (close/medium/far away)?

We zitten in Maasdijk (bij de Hoek van Holland).

- Our main location is in Maasdijk (50-65 km from Maasvlakte terminals)

4. How many containers do you receive from and send to the terminals in the port of Rotterdam per day on average?

We doen 12 containers per dag via terminals op de Maasvlakte in de Rotterdamse haven.

- On average 12 containers per day from the terminals on the Maasvlakte

5. Are you (always) responsible for the transportation between the port and your location?

Ja in principe wel, want willen onze strakke planning in onze eigen handen houden. Paar enkele keren waren wij het niet (maar dat waren er erg weinig) en dat is erg onwenselijk.

- Yes, we are normally always responsible because we want to be in charge of our own schedule
- Only a few times it was not us and that was undesirable

6. How does the process work of ordering and planning the transportation of a container?

We hebben één vaste vervoerder: die krijgt 1 keer per dag de opgave van wat hij precies de volgende dag moet doen (en precies hoe laat elke container er moet zijn). En 1 keer per week hoort die wat die ongeveer de volgende week moet doen. Wij stemmen dat elke dag om kwart voor 11 af met inbound en outbound enz. Dan geven we dat door aan onze vervoerder (nu via een mail met Excel, maar we werken naar een systeem toe).

- We have 1 carrier/trucking company.
- They receive every day what they have to deliver the next day (and exactly what time)
- At the beginning of each week they hear roughly what they have to do
- Every day in the morning we coordinate the schedule with inbound and outbound

7. How do you interact with carriers, freight forwarders and other actors?

We zien in Portbase wanneer de rederijen/terminals een container hebben vrijgegeven. Als dat is gebeurd, nemen we contact op met de vervoerder voor het ophalen van de containers (en het leveren de dag erna). Nu mailen we onze vervoerder elke dag een Excel bestand met de tijden dat de containers er de volgende dag moeten zijn, maar we werken naar een systeem toe.

- Portbase: see when terminals have released a container
- Carrier: we email them an Excel file every day with the times containers should arrive
- But in the future we want to use a system instead of email

8. How are contracts with carriers or freight forwarders created?

We gebruiken niet echt contracten in deze wereld. Maar we hebben al 8 jaar hetzelfde vervoersbedrijf, dus dat zal niet zomaar veranderen. Als het heel druk is en nodig is, regelt de vervoerder zelf nog andere vervoerders (charters) voor ons transport. Maar we willen zoveel mogelijk hetzelfde materiaal (onze vervoerder). Anders krijg je namelijk vaker vervoerders die niet op tijd zijn.

- We don't really use contracts, but we work with the same carrier for 8 years so it won't change
- If it is really busy; our carrier sometimes uses charters for our containers (they contact them)
- But preferably we use our own carrier, otherwise more chance of arriving too late

9. What is your role in the time scheduling of container pick-up/delivery?

Allemaal uitgepland (beperkte ruimte en bezetting). Soms ruimte maken om containers binnen te halen. Hele dag door komen containers aan. Nadruk op de ochtend. Openingstijden zijn 6-7, maar binnenkomsten 6-4. Op de minuut moet de vervoerder er zijn (6 uur 's ochtends; kwartier ervoor moeten ze er zijn). 1 minuut te laat is te laat. Wij accepteren geen tijdslots.

- It is all planned out because of our capacity (per hour)
- Most containers arrive in the morning, our opening hours are from 06:00 to 19:00, but containers arrive between 06:00 and 16:00.
- The trucking companies have to be there on the minute precisely: one minute too late is too late
- At 6 o'clock in the morning they have to be a quarter early
- We don't work with time slots

Questions on waiting times at container terminals:
10. Do carriers sometimes arrive too late with the containers at your facility?

Ja, de meeste zijn op tijd, eerder op de dag is dat 90/95%, later op de dag vervalt dat naar 80%. In de spits of keer ritten gaat het soms naar 70%. Dat weten we, maar op de dag afhalen van terminal is moeilijk. Vervoerder ook er ook niet echt wat aan doen als ze te laat zijn. Wij houden het bij en houden ze scherp. Er moet 's ochtends materiaal zijn. Verder willen we wel dat het op tijd is, maar is het geen ramp. Meten op minuut te laat, maar geen kwartier.

11. Do you know the reason behind late arrivals of containers? If yes; please explain

Wij kunnen zelf de reden zijn (als het lossen langer duurt, gaan uit van 1 uur. Als iets met kwaliteit aan de hand is: 1,5 uur). Zelfde wagen voor volgende container kan dan te laat zijn. Of door congestie op terminal zelf: rekenen 1 uur 1,5 uur voor ophalen containers. Als er file staat: duurt het langer

12. Do you have to pay carriers/freight forwarders for the waiting times at container terminals?

Wij zijn daar coulant in. Hangt ervan af hoe erg het is. We zijn wel bereid om dat mogelijk te betalen (partnership). Als het uit de hand loopt; wat is fair? Misschien zullen we een deel betalen. Het ligt ook aan wat in de vaste prijs is mee gerekend.

13. Are there consequences for carriers for arriving too late at your facility and if yes, what?

Nee maar als ze regelmatig te laat zijn moeten ze bij mij om tafel. Maandelijks hebben we een call met vervoerders zodat het niet uit de hand loopt: dan vragen we waardoor komt het? Bijvoorbeeld door een verkeerde planning, dat kunnen ze verbeteren.

14. What are the consequences of these late arrivals for all your processes?

Eerste stuk in de ochtend: 20 man stil, dan is een uur super lang. Later op de dag minder effect. Wij gelukkig minder effect dan als ontvangers van containers een directe verkoop van containers hebben: dan staat hun klant ook te wachten, dat is een gestresst proces. Iedereen moet stretch hebben om keuring optijd te hebben. Hebben veel mensen wel (A voor A planning; vandaag voor vandaag): veel uit de markt (zien wij als verstoring want te afhankelijk: het is niet zeker of het er om 11 uur is). Wij hebben in de meeste gevallen alleen als gevolg dat de productie staat te wachten (want kwartier/uur te laat beperkt). Onze grootste focus is de ochtend. Of later op de dag: stilvallen; opgegeven moment werk op (we hebben vaste medewerkers dus het is niet verschrikkelijk). Als het op het laatste moment van de dag wat rustiger is, kunnen we inhalen. Of we nemen een container niet aan als het is uitgelopen en ze te laat aankomen. Dan pluggen we hem in op ons terrein. Vervoerder vindt dat geen probleem; kan lastig zijn maar ze weten hoe we werken. Einde dag gaan ze toch niet veel meer doen: volgende ochtend kunnen ze dan alleen iets later beginnen, omdat die container nog moet worden uitgehaald (25 euro per dag).

15. How do you think these waiting times could be mitigated?

Door 's nachts uit te halen (hebben we zelf onderzoek naar laten doen): in praktijk lange testen mee gedaan, maandelang. Conclusies: ja het werkt, ja gegarandeerde levering. Maar je blijft afhankelijk van grillen haven (binnenkomst schepen blijft leidend). Voorraad posities moeten goed zijn (in staat zijn buffer te hebben) anders druk op keten. Off- tijd stijden. Pluggen bij jezelf en dan volgende ochtend. Terminal tracker moeten hebben eigenlijk (1 wagen heen en weer rijden in de nacht). 1 nadeel menselijk oogpunt: chauffeurs die in de nacht moeten rijden.

16. Does your company accept container at night and if yes/no; why?

Jawel we laten het aan onze vervoerder. Hij kan vanmiddag al containers neerzetten voor morgen. Vervoerder kan met zijn kenteken op terrein. Dus die kan gewoon vrij erop om 's nachts ophalen. We hebben alleen niet de focus op proces dat containers per se aan stekker. Grootste deel in vroege avond tot nacht werd dat gebracht. 2e shift wissel: ergens begin nacht (terminal): funest want sta je een uur stil. Bij gemiddelde doorlooptijd 1,5 uur (gemiddeld overdag). 's Avonds: kan een kwartier (15 min). Helpt heel erg voor vervoerder. Voor ons fijn tijdigheid (willen we sowieso). Terminal en vervoerder winnen.

17. What is your role in the time scheduling (day/night) of container transport?

Alles is voor ons oké als de container er maar op tijd is.

18. Do you think being open at night adds/reduces costs/benefits for you and why?

Er is voor ons geen financiële prikkel; dan zouden we nieuw project moeten doen, breder insteken. Geen andere kosten voor ons denk ik.

19. How do you think the constraints of night-time container transport could be relaxed?

Dat hele stuk is wat je moet doen om de wereld te verbeteren. Zeg ik al heel lang. Je moet dit doen om de wereld te bereiken. Elk industrieterrein: gedeelde hub moeten hebben. Wij hebben een eigen, het werkt, maar aandacht aan besteden. Als je centrale hub hebt: het werkt en je kan het ook verplichten. De toename gaat blijven versnellen en terminals kunnen het niet aan. Wij doen het niet, wij willen het niet" zeggen sommige bedrijven. Die mogelijkheid die wij hebben (stekkeren en

neerzetten hebben meer bedrijven).

20. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?

Ik denk chassis-exchange want dat maakt het laagdrempelig. Vaste vervoerder en eigen vervoerder kan je het doen. Niks voor nodig: alleen chauffeur. Anders reach stacker nodig (inland terminal bijvoorbeeld); kost heel veel geld. Dan ben je zoveel complexiteit aan het toevoegen. Terwijl juist 4 hekken en een stroompunt: 1 maand en niet ingewikkeld (chassis-exchange). Kracht capaciteit (stroom) is wel nodig. Er moet stroom zijn. Maar als dat er is: niet zo ingewikkeld. Toegang regelen op nette manier.

21. What is your role in the route scheduling of a container?

Aan de vervoerder zelf. Bij meerdere vervoerders: control tower neerzetten. Maar dat is niet zo moeilijk; bereid zijn samen dingen te doen. Ik heb aantal zulke projecten te doen. Wat als hij dat weet? Mijn tarieven? Doet er toch helemaal niet toe. Daar kan je toch wel achterkomen.

22. What are the constraints of a hub with extended opening hours as a concept?

Gebruik van zo'n hub kan je op zelfde manier zien als elektrische laadplaatsen. Degene die er staat die betaalt de stroom. Als vervoerder niet kan terug winnen (de chassis) met de efficientie: verkeerde vervoerder. Camera is niet veel en beheer van industrieterrein zijn er al. Spannendste is investering, paar tonnen: kijken naar het Rijk (en misschien havenbedrijf). Investering van bedrijven is wel lastig want wat win je? (aantoonbaar: op chauffeur win je zoveel per dag). Als je dat soort cijfers laat zien aan vervoerders: gek als niet investeren. Zeker elektrische wagens.

23. How do you think these constraints could be relaxed?

Je loopt tegen van alles dingen aan. Het kan niet altijd (zit met je lossing) kan alleen als je partnership met vervoerder. Soms 60/70 containers op schip. Maakt niet uit: zet maar aan de stekker. Je moet wel hoop vrijheid en vertrouwen geven en vrijheid hebben om dat te doen. Afzetten hoeft niet per se 's nachts. Je moet goeie relatie hebben.

24. To what extend do you think it would beneficial for you to invest in a hub with extended opening hours and why?

Daar loopt het vaak fout; op deze manier aan markt: Ja mar het kost hgeld. Onze wereld vrij ouderwets (mensen zijn blind): kosten nacht chassis, kosten nacht werk. In mijn optiek zijn de faalkosten (van stilstaan) veel hoger. Is eigenlijk waanzinnig duur: maarja ze waren toch al in dienst: verlies je argument. Ik zit op het andere uiterste: doorstroom is belangrijk. Dat vind ik een hoop waard. Als je het hele trucje consequent gebruikt. Vervoerder laatste : toestaat containers: benut mensen veel optimaler chauffeurs (vervoerder). Uiteindelijk in de keten win je daar zoveel mee. Van 1,5 uur naar half uur: win je zoveel. Maar je moet het wel consequent moeten doen. Je zou het regionaal moeten doen. Onze vervoerder gebruiken stekkers ook voor andere. Cool control hebben net zoveel containers als wij; zelfde vervoerder. Kruisverbanden: zolang ik niet weet wat er in zijn container zit: maakt mij niet uit. Vooral stukje echt wat verbetert: in principe ook CO2 stukje; file vermijden is beter. Voor alles. Planning optimaal (is mijn focus). Als je dit consequent doet en uit de file: beter milieu. Als je dit goed doet: makkelijk elektrische voertuigen (wanneer opladen?) zit je zo 4 jaar verder. Wanneer zouden ze doen? Als laten zien dat het beter is.

G.3. Terminal

G.3.1. Terminal A

General questions about terminal and processes:

1. What kind of terminal are you?

We zijn een maritieme deep sea terminal. We zijn eigenlijk een buitengrens van Europa. De meeste van onze containers komen van buiten de Europese Unie (import), en we doen natuurlijk ook export. Verder doen we ook een klein beetje continentaal (maar dat doen andere terminals zoals RSC meer). We doen niet echt een bepaald type container. Ja we doen

geen speciale containers trailers die op een trein gaan, maar gewoon standaard maritieme containers (20, 40, 45 ft). We hebben aan de ene kant de waterzijde (waar grote zeeschepen binnenkomen en vertrekken). Aan de andere kant hebben we de landzijde, waar we werken met trucks, treinen en binnenvaartschepen. We zitten redelijk in lijn met de algemene Rotterdamse modal split (ongeveer 35% binnenvaart, 10% spoor en 55% truck).

- Maritime deep sea terminal with import and export (mainly from/to outside Europe)
- Standard maritime containers (20, 40, 45 ft)
- Waterside with deep sea ships and landside with truck, train and barges

2. Do you know the approximate number of trucks arriving at your terminal per day?

Bij terminal A komen er ongeveer 14.000 trucks per week langs op containers op te halen en/of te droppen. Deze komen vooral binnen op weekdagen en overdag. Bij terminal B komen er ongeveer 8.000 trucks per week binnen.

- Terminal A: around 14.000 trucks per week
- Terminal B: around 8.000 trucks per week

3. Do you know the approximate number of containers leaving from and arriving at your terminal on a truck per day?

Bij terminal A zijn er ongeveer 18.000 containers per week die gebracht worden of opgehaald worden per vrachtwagen. Bij terminal B zijn dit er ongeveer 11.000.

- Terminal A: around 18.000 containers per week (per truck)
- Terminal B: around 11.000 containers per week (per truck)

4. How does the process work of trucks arriving at the gate?

We werken niet met tijdsloten (staat wel al een tijd op agenda voor misschien in de toekomst). Container informatie moet wel worden voorgemeld (vaak via Portbase; dat je hem komt halen of opbrengen), maar degene die het vervoer regelt hoeft geen informatie over de rit of vrachtwagen (dus wie hem wanneer precies komt ophalen) voor te melden. Van de rederij krijgen ze een pincode als de container commercieel is vrijgegeven (als de container er is en er is voor het transport betaald, of de rederij weet bijvoorbeeld zeker dat er betaald gaat worden). Met deze pincode kunnen ze dan de container komen ophalen/brengen.

- No time slots (are on the agenda for the future)
- Container information is needed beforehand (Portbase)
- But no information needed about truck (trip)
- Trucking company receives pin code from the deep sea carrier if they have received the money and if the container is ready for pick up/export

5. How does the process work for trucks when they have entered the terminal?

Eerst moeten ze door de eerste slagboom ("security in") met hun cargo card. Daarna is er de "rit samenstelling" waarbij de voormelding gekoppeld wordt aan de transactie. Oftewel de chauffeur geeft aan wie hij is en voor welke container(s) die komt. Bij de ... moet de chauffeur naar binnen en dit zelf invullen op een computer scherm en krijgt die een briefje met waar die heen moet. Bij de ... Terminal kan dit vanuit de cabine en typt hij dit in op een scherm en weet die waar die heen moet. Daarna ligt het aan waar die heen moet en hoe druk het daar is, of hij daarna nog moet wachten. De terminals zijn redelijk groot en verdeeld in ranges (sommige zijn drukker dan anderen, als er bijvoorbeeld net ergens een groot schip binnen is). Per range is er een maximaal aantal trucks wat tegelijkertijd afgehandeld kan worden. Als dat nog niet aan de max zit kan een vrachtwagen na de rit samenstelling meteen door. Zo niet, dan moeten ze op een parkeer terrein wachten (aan het begin van de terminal maar wel al binnen de hekken). Het is nieuw dat ze via de app per kenteken informeren of de vrachtwagen al aan de beurt is. Voorheen ging dat in de Delta in de wachtruimte op een scherm. Bij de ... hing er buiten een groot bord. We hebben ook een remote check-in ontwikkeld (dat de chauffeur op afstand kan aangeven wie hij is en voor welke container(s) hij komt). Dan hoeft een chauffeur er bij de ... ook niet meer uit. Nu wordt deze doorontwikkeld door Portbase. Containers die naar de scan moeten voor (douane) check voor de inhoud of potentiële inhoud, worden pas op het laatste moment door de douane geblokkeerd en kunnen dan toch niet worden vrijgesteld. Douane scans gebeuren nu op onze

terminal zelf (vroeger aan de overkant van de weg), maar voedsel keuringen gebeuren op een aparte locatie. Die zijn dan als ze daarheen gebracht worden nog niet vrijgegeven maar worden door partijen vervoerd die daarvoor gecertificeerd zijn. Misschien gebeurt dit transport zelfs via onze interne baan; wat een gesloten route is vanaf onze terminal. Die interne baan leidt vanuit onze terminal ook naar een depot voor lege containers en een aantal distributiecentra op de Maasvlakte. Wij hebben een eigen transportbedrijf wat hiertussen rijdt. Naar het depot is zelfs een multi-trailer systeem (bijvoorbeeld 10 20ft containers tegelijkertijd in een treintje). Deze wordt bijvoorbeeld gebruikt als een rederij ineens 200 lege containers nodig heeft voor een schip naar China (het liefst zo kort van tevoren mogelijk zodat het niet in de weg staat op de terminal). Dan rijdt onze vervoerder in de nacht deze containers tussen het depot en de terminal. Vervoerders leveren in principe hun lege containers zelf af bij het depot. De rederij bepaalt, op basis van equipment control (waar staat welke van hun containers op de wereld?), waar vervoerders lege containers moeten afleveren. Soms vraagt een vervoerder "ik ben toch al in Venlo, kan ik hem hier afleveren?". Meestal kan dit wel maar dan voor een drop off fee (van ongeveer 25-40 euro). Wij hebben contracten met rederijen, geen commerciële relatie met wegvervoerders. De rederij regelt het verdere landtransport (of zelf, of een forwarder of verlader die een contract heeft met een rederij). Merchant haulage (waarin de verlader/forwarder het vervoer regelt) komt in Rotterdam ongeveer 70-80% van de keren voor. Carrier haulage (waarin de rederij het vervoer regelt) ongeveer 20-30%. De ... terminal is het meest geautomatiseerd. Een chauffeur kan hier zelf het hele rondje af. Het enige punt waar een persoon zit is de stack kraan. Deze komt automatisch boven een vrachtwagen te hangen, maar voor de laatste paar centimeters is een persoon nodig die vanuit binnen, voor meerdere plekken tegelijk, met camera's en joysticks de container vast pakt (de chauffeur kan namelijk nooit precies altijd op dezelfde plek staan). Op deze plek zit altijd iemand (als één iemand aan het eten is, zit er iemand anders). We wilden dit stukje door chauffeurs zelf laten doen, maar dat mocht niet van vakbonden omdat het haven medewerker werk is volgens hen.Op de Delta terminal is het meer manueel. Het verplaatsen van containers gebeurt door carrier (persoon die het apparaat over de vrachtwagen heen rijdt en dan de containers eraf en erop zet. Daar zit dus nog wel echt iemand in de machine, en die moeten wel eten. Ze proberen gespreid te eten maar er is altijd wel een pauze waarin er minder capaciteit is en er soms niet overal iemand meer zit. Dienstwissels en pauzes zijn bekend online.

- First through the security gate with their cargo card
- Then they need to say who they are and for which container(s) they are here
- Terminal A: truck driver needs to go inside to a computer to do this
- Terminal B: can be done from within the truck through the window
- Then they receive a note with the location to go for that container
- After that they can pick up/leave a container or they first have to wait, depending on if it is busy at the range the truck needs to go (depending on when deep sea ships arrive/leave)
- Customs scans are at our terminal, food inspections at other location (before being released)
- We have an internal road from terminal to the empty depots and DC at the Maasvlakte, with our own trucking company travelling on it (used for example when deep sea carrier needs 200 empty containers for ship to China. Trucking companies normally need to go to depot for leaving empty containers (deep sea carrier determines where they have to go; if at other location; most of the time 25-40 euro dropping off fee).
- We have contracts with deep sea carriers, no commercial relationship with trucking companies
- Deep sea carrier arranges land transport itself (carrier haulage: 20-30%) or with forwarder/shipper (merchant haulage: 70-80%)
- Terminal B most automated (only manual for last cm of crane to truck; always a person there to do that). Delta terminal more manual: also the process of crane moving over truck; this process is influenced by breaks and shift changes (less capacity during dinner time)

6. Are you open for truck arrivals at night?

Ja.

- Yes

Questions on waiting times at container terminals:

7. Do you perceive waiting times for trucks at your, or other terminal gates' and how?

Ja, we zien zeker wachttijden. Vooral in de ochtendpiek (vanaf ongeveer 5 tot 8 uur 's ochtends) en aangezien chauffeurs in de middag vaak nog een 2e of 3e ritje willen doen is er ook een middagpiek, die wordt wel steeds iets breder.

- Yes, especially in morning peak (from 5-8). And there is also an afternoon peak

8. What do you think are the reasons for these waiting times?

De redenen zijn vooral dat alle vrachtwagens tegelijk komen, door de sluitingstijden van plekken waar chauffeurs de containers moeten afleveren, zoals distributie centra. Daarnaast zullen er natuurlijk ook wel eens calamiteiten of storingen zijn bij ons, of bijvoorbeeld een storm. Maar de voornaamste reden voor de wachttijden elke dag is dat de haven een 24 uur operatie heeft, maar de rest van de logistieke keten niet.

- Times that trucking companies have to be at a receiver
- Of course sometimes calamities/breakdowns of our equipment, or a storm
- But normally it is because we are open for 24 hours, but the rest of the logistics chain is not

9. What are the consequences of these waiting times in peak hours for you as terminal?

Ten eerste natuurlijk een hoop gemopper van vervoerders die moeten wachten voor onze terminal. Daarnaast hebben wij een groot stuk grond nodig waar de vrachtwagens moeten wachten, wat duur is in de haven. Op dit stuk grond hadden we ook containers kunnen neerzetten en geld kunnen verdienen. Ook is een wachtrij voor de terminal niet goed voor de service kwaliteit en de perceptie van de wegvervoerder. Puur operationeel gezien is een wachtrij voor ons niet alleen maar slecht. Door de wachtrij is er overdag altijd voorraad om af te handelen, wat efficiënt is voor onze processen. Bij nieuwe terminals met tijdsloten komen vervoerders soms bijvoorbeeld niet opdagen, en dan wordt die capaciteit gewoon niet gebruikt. Dat probleem heb je niet bij onze terminals. Door het feit dat iedereen overdag komt leidt er wel toe dat de belasting overdag heel groot is op de landzijde. Dan hebben we het te druk met trucks, treinen én binnenvaartschepen. De capaciteit van de terminal wordt minder goed benut, processen wringen en ook de betrouwbaarheid van de onze dienstverlening is minder goed.

- Angry trucking companies that have long waiting times
- Also; the ground where they are waiting we could have been using to make money
- Poorer service quality and perception of the terminal for trucking companies
- Operationally a waiting queue is also efficient, as there are always enough trucks to handle
- But because of only during day: the load is not equally spread which means the capacity is used less effectively and the reliability of our services is less good

10. How do you think these waiting times could be mitigated?

Vervoerders zeggen dat wij als terminal meer mensen moeten inzetten om de wachtrij te verkleinen, maar op gegeven moment is de maximale capaciteit van de terminal bereikt (qua infrastructuur), dus dan heeft het geen zin meer om meer mensen neer te zetten. De wachttijden zouden natuurlijk ook lager worden als vrachtwagens meer gespreid zouden aankomen bij onze terminal, dus bijvoorbeeld ook in de nacht en tijdens het weekend.

- Trucking companies say that we should hire more people to handle containers during the day, but at some point the maximum capacity of the terminal is met, so it does not help anymore
- Waiting times would of course be less if truck arrivals would spread more (so also at night)

11. Have you tried reducing these waiting times and if yes, how?

Ja zoals het artikel wat ik naar je stuurde ("Proef gegarandeerde nachtafhandeling van containers"), waarin we tussen 22.00 en 4.00 een maximale verblijftijd op de terminal garandeerden. Volgens het artikel kon een vervoerder een vergoeding tot 40 euro krijgen van de terminal als de maximale verblijftijd (45-75 min) overschreden werd. Deze proef werd gedaan zodat vervoerders betrouwbaar hun vervolgroute kunnen plannen, de doorstroming van containers te verbeteren, de capaciteit van de terminals beter te benutten en een bijdrage te leveren aan het voorkomen van congestie in de haven (Proef gegarandeerde nachtafhandeling van containers - Logistiek).

- Yes, we guaranteed the maximum dwell time (45-75 min) at the terminal between 10pm and 4am. Otherwise trucking companies could receive compensation (up till 40 euros), so that trucking companies could plan more reliable, to improve the container flows, to better utilize the terminals capacity and to contribute to preventing congestion in the port.

12. Is it beneficial for you to have more night-time container transport/arrivals?

Ja dat is wel voordeliger voor ons. Dan wordt de terminal gesprijder belast. Nu is er aan de landzijde veel piekbelasting door alle vrachtwagens, treinen en binnenvaartschepen die we tegelijkertijd moeten afhandelen. Als het wegvervoer ideaal gespreid zou zijn over de week zou dat beter zijn voor de terminal. Ten eerste zou de betrouwbaarheid van onze dienstverlening zou erop vooruit gaan. Daarnaast maken we nu overdag maximaal gebruik van onze resources (mensen en apparaten). Door het beter te spreiden van transport gaat het minder wringen op bepaalde momenten van de dag. De vrachtwagenchauffeurs zouden betere servicetijden krijgen omdat er minder wachttijden zouden zijn.

- Yes, spreading the truck arrivals to the night would be good for the terminal
- Now a lot of peak load at the land side during the day (trucks, trains, barges)
- More arriving at night: more reliable service for trucks
- More arriving at night: more efficient use of our resources (people and machines)

13. What are the constraints of night-time container transport?

Ontvangers van containers zijn 's nachts niet open, waardoor vervoerders niet 's nachts komen. Omdat we weten dat er maar weinig vrachtwagens komen, zijn er op dit moment 's nachts weinig mensen aan het werk op de terminal. Als we zouden weten dat er meer mensen zouden komen, kunnen we meer mensen 's nachts inzetten.

- Receivers not being open at night
- We do not plan a lot of people to work at night if we know almost no one is coming

14. How do you think these constraints could be relaxed?

Er zijn een aantal weg vervoerders waarvan ik weet dat ze zelf een hub hebben zodat ze 's nachts kunnen rijden. Zo'n hub zou wel een goed idee zijn denk ik. Vanaf onze kant hebben we dus wel eens wat geprobeerd (zoals bij vraag 10), door te garanderen dat de doorlooptijd 's nachts goed is voor vrachtwagens. Dit zouden we in de toekomst misschien weer kunnen doen als er bijvoorbeeld zo'n hub komt.

- A hub that is open at night (some carriers have that themselves)
- We tried to help (see question 10) by ensuring a maximum dwell time at night
- Maybe repeat this in future

15. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?

Dat zou je moeten doorrekenen. Een reach stacker die je nodig hebt bij een container terminal is niet gratis en daar moet iemand de hele tijd op zitten. Dan is het bijna een inland terminal. Het zou misschien werken voor grote aantallen. Gevoelsmatig zou ik zeggen dat een chassis exchange beter zou werken omdat chassis huur niet zo veel is. Maar dat zou je moeten uitrekenen.

- A reach stacker is not free, an employee needs to be using it the whole time. A container hub is almost like an inland terminal. It could maybe work with large amounts of containers.
- Chassis exchange might be easier to be efficient as it is cheaper. But you would have to calculate it

16. Do you think carriers using a hub with extended opening hours would add/reduce costs for you and why?

Het ligt er natuurlijk aan hoe je het inricht, maar in principe zou zo'n hub wel positief voor ons zijn als het zou leiden tot een betere spreiding van vrachtwagens naar de nacht. Het aantal vrachtwagens wat bij ons aankomt per dag is wel fors, dus ik weet niet of het meteen voelbaar zou zijn. Maar in principe is meer spreiding sowieso positief voor onze dienstverlening (service naar vrachtwagens).

- More trucks at night is positive for us and our service quality
- But not sure if we will feel it immediately (a lot of trucks per day)

17. What are the constraints of implementing a hub with extended opening hours and how do you think these constraints could be relaxed?

Bij een inland terminal wordt het eerste stuk met spoor en binnenvaart gedaan (van terminal naar inland terminal) en dan het tweede stuk met de vrachtwagen. Het is natuurlijk een beetje gek als je 2 keer vrachtwagen transport uitvoert. Het zou wel kunnen werken voor belangrijke containers die echt op tijd moeten zijn. Als je dat veel per vervoerders hebt en veel vervoerders: dan is het logisch. Binnenvaart gaat snel over paar dagen. Het is inderdaad iets minder betrouwbaar en flexibel (iets robuuster).

- Who will want to use and pay for it?
- Maybe customers that really want some containers on time (maybe fruit and electronics)

18. Do you think you would possibly invest a hub with extended opening hours and how?

Denk eerlijk gezegd niet dat wij in zo'n hub zouden investeren. Wij investeren al in sommige inland terminals (zoals in Venlo, Duisburg en we zijn aandeelhouder in Moerdijk). We zouden dan moeten afwegen of het wel rendabel is. Wat zouden we kunnen doen met de extra grond die we hebben (die we niet meer hoeven te gebruiken als parkeerplaats voor wachtende vrachtwagens). Ik denk dat vervoerders en klanten die er meer baat bij hebben eerder zouden willen betalen. Sommige vervoerders gebruikten op gegeven moment ook een afkoppelplaats (hub) omdat vervuilende vrachtwagens niet meer de Maasvlakte op mochten, en ze die dan wel nog konden gebruiken. Vanuit de terminal zouden we waarschijnlijk niet investeren, maar bijvoorbeeld wel helpen met het proces van zo'n idee. Misschien dat we weer zouden kunnen zorgen dat er in (in ieder geval een deel van de) nacht meer mensen zijn ingezet, zodat ze 's nachts snel weer weg kunnen van de terminal. Maar dat ligt natuurlijk aan de aantallen containers die 's nachts zullen komen in dat geval.

- We already invest in some inland terminals, don't know if we would do it for this one
- It would have to be profitable (what will we do with the extra ground that was parking space?)
- Probably trucking companies and clients would want to invest
- We could maybe help by ensuring a maximum dwell time at the terminal at (part of the) night

G.4. Freight forwarders

G.4.1. Freight forwarder A

General questions about company and processes:
1. What service do you give as a company?

We regelen containervervoer, vooral reefers (doen er ongeveer 17,5 tot 20 duizend per jaar). We zijn een expediteur, een soor tussenpersoon, omdat we andere vervoerders gebruiken voor het transport.

2. How many carriers/trucking companies are you working with, and about how many trucks do they have?

We gebruiken ongeveer 10 tot 15 vaste transporteurs. Dit is een combinatie van grote en kleine transporteurs. Er zitten ook een paar eigen rijders (met 1 truck) tussen.

3. Does your company have a (shared) hub/depot/DC/parking place and if yes; what kind of?

We hebben een kantoor in Barendrect maar sommige van onze transporteurs hebben eigen depots met trucks. Als het goed is kan een transporteur 3 keer op en neer naar Barendrecht in een dag.

4. How does the process from the which of a shipper to the transportation of containers work?
5. How do you interact with carriers, receivers, terminals, hubs?
6. How do you set-up your contracts with shippers?

We hebben afspraken op basis van groente en fruit seizoenen; die duren een jaar. In dat jaar regel je al het vervoer voor het bedrijf/importeur. De weekplanning verwachting krijgen wij van bedrijf. Dan kijken wij op de websites van terminals; waar en hoe laat komen ze binnen? Als we weten wanneer ze klaar staan: gaan wij de keuring regelen. Dan koppelen we het duane document eraan en sturen we de transporteurs een vrijstelling om te gaan. De opdrachtgever krijgt kopie hiervan

en weet dan hoe laat de containers komen. Dit gaat allemaal in overleg (stel ze willen 10 containers hebben, kijken we of er bepaalde belangrijke zijn die er optijd/eerder moeten zijn). We werken met vaste ritprijzen. Maar er is wel een variabele diesel toeslag (die gaat nu heel erg omhoog). Maar we zijn ook afhankelijk van ISCO (kostprijsstijging van min 10%). Dat is een CAO, omdat chauffeurs hogere lonen moesten krijgen.

7. Who makes decisions about the time of container transport/pick-up/delivery and how?

Dat gaat in overleg met de klant. Die geven aan hoe laat ze willen dat elke container er is. De vervoerders kunnen zelf bepalen hoe laat ze precies naar een terminal gaan.

8. Do you collaborate with other freight forwarders?

Ja we kijken soms samen met een partner wat we kunnen doen als er tekorten zijn. Maar er is een gebrek aan transporteurs en chauffeurs. Dus er is niet veel flexibiliteit meer. Daardoor ontstaat er een probleem op terminals want aan de voorkant (de zeekant) zijn er veel containers, maar aan de achterkant stagneert het.

Questions on waiting times at container terminals:

9. Do you perceive waiting times at terminal gates' in the port of Rotterdam and how?

Ja, dit merken we. Hierdoor kunnen we geen planningen meer maken.

10. What do you think is the reason for these waiting times?

Het probleem op de terminals wordt veroorzaakt door rederijen, die wijken af van hun schema's. Ook worden de schepen steeds groter en groter; het aantal containers is te veel voor de terminals. De terminals zijn niet voorbereid en de rederijen maken er een bende van. Transporteurs zitten dan met de uitdaging. Ook insluipers in de haven zijn een probleem.

11. What are the consequences of these waiting times for you as freight forwarder?

Dat we geen planning meer kunnen maken. Groente en fruit zijn ook vaak gekoppeld aan weekprogramma's met de supermarkten (die starten op vrijdag). Wat moeten we dan doen als er containers te laat zijn? Sommige rederijen gaan nu naar Zeebrugge, omdat Rotterdam te druk is. Maar een barge is altijd te laat en truckers zitten niet in Zeebrugge. Er zijn geen barge aansluitingen en geen slot tijden. De wachttijden bij de terminals zorgen er ook voor dat het oplossen van het barge probleem niet gaat. Sommige containers worden dan naar Antwerpen gestuurd, maar dat is niet veel beter dan Rotterdam.

12. Do you charge shippers for the waiting times at terminal gates and if yes; how?
13. Do you charge carriers for arriving too late at receivers and if yes; how?

Iedereen heeft belang bij vervolg containers aangeleverd, dus we willen en kunnen geen boete geven. Soms krijgen we kosten door een losploeg die niks kan doen. Dan belasten we die wel door naar de transporteur. Maar ik vind dit niet echt terecht omdat ze er niks aan kunnen doen. De opdrachtgever moet eigenlijk het risico dragen voor de transporteurs. Eigenlijk horen de kosten voor de rederijen te zijn, mar die accepteren ze niet. Alle wachttijden die je hebt zijn kosten verhogend. Uiteindelijk is het voor heel Rotterdam nadelig. De meeste keren belasten wij extra kosten voor wachten door naar de opdrachtgever. Op dit moment komt het echt door vertraagde boten, te grote boten en vertraging tijdens lossen. Het is een stukje arbeidsonrust in de Rotterdamse haven. Er is ook een gebrek aan transport. TLN is bezig met een wervingsactie voor 20.000 chauffeurs.

14. How do you think these waiting times could be mitigated?

We moeten praten met veel partijen, dit kunnen we niet alleen oplosen. Er moet meer gebruik worden gemaakt van transporteurs, maar soms zitten alle groente en fruit op dezelfde schepen. Het begint allemaal bij de arrogantie van rederijen (met hun idooit hoge prijzen). Het is toch niet moeilijk om op tijd te varen en aan te komen?

15. Do your carriers perform night-time container transport at this moment and why?
16. What are the constraints of night-time container transport?

We proberen dat wel maar omdat boten steeds groter zijn gaat dat moeilijker. Voorheen was het makkelijk; binnen 24 uur was een boot leeg en geladen en weg. Maar nu kan dat niet meer want schepen blijven langer liggen dus heel moeilijk plannen. We hebben meegedaan aan een subsidieregeling voor spits mijden; maar dat werkt niet goed door omdat de barges geen slot tijden hebben. Omdat de barges vol zitten en boten langer lossen; het duurt te lang voor groente en fruit. Vaak zijn goederen 36 tot 48 uur later. Terminals zijn open voor 24 uur maar in bepaalde uren is er nagenoeg geen container afhandeling (waar zijn de transporteurs?). Een probleem is; chauffeurs die nacht moeten rijden. We hadden een project een paar jaar geleden; Fresh corridor, door de overheid en de haven: hoe kunnen we reefer containers van de weg halen? Dit is echter een vroege dood gestorven.

17. Who chooses the time scheduling (day/night) of container distribution?

Dat is tweeledig. Ten eerste hebben we te maken met de rijtijden wet (transporteur moet de mogelijkheden hebben, als je bijvoorbeeld zondag/maandag nacht wil beginnen, moet je de hele week in de nacht rijden; kan dat ook?) Met reefer containers kan dat niet echt want container schepen met reefers komen maar een paar dagen van de week aan; en dan lukt dat dus niet. Ten tweede bepalen ontvangers of de containers 's nachts bij hen aan kunnen komen. Zij willen bij het lossen van de container zijn om te checken of de temperatuur niet is gezakt of gestegen isen of het product nog goed is. Daarom staan de meeste ontvangers niet toe dat vervoerders 's nachts bij hen lossen. De meeste koelhuizen hanteren openingstijden van half 8 's ochtends tot 5 uur 's middags.

18. Do you think night-time transport (would) add/reduce costs/benefits for you and why?

Een koelhuis in Gorinchem die 's nachts open is, daar leveren we wel 's nachts heen. Sommige laatste containers leveren we daar om 12 uur. Het kosten verschil met nacht dag is dat de kosten hoger zijn 's nachts, maar je kan meer containers doen. Ik denk dat je uiteindelijk een beetje op gelijke overall kosten komt.

19. How do you think the constraints of night-time transport could be relaxed?

Een hub die 's nachts open is gebeurt soms wel al maar kosten technisch zie ik wel een probleem. Groente en fruit mag maar paar uur zonder koeling (de ontvanger wil graag minder dan 24 uur) . Lege chassis zijn er te weinig: die huur je nu of je hebt ze: maar de beschikbaarheid is zeer gering. Dan zouden er meer van gemaakt moeten worden. Ook is de huidige inrichting van infrastructuur is niet genoeg om de groei te voorzien.

20. How would you as a freight forwarder want to arrange the night-time transport between the terminal and the hub and the day-time transport between the hub and the receiver (with one or multiple carriers) and why?

Door echt te kunnen zeggen; dit zijn containers die we hebben, hoe gaan we zorgen dat deze het efficients van plek naar plek gaan. Transporteurs moeten containers echt kunnen loslaten. Dus met meer transporteurs werken voor bijvoorbeeld 1 container (1 doet het nacht vervoer, de ander het dag vervoer). Maar transporteurs gunnen het elkaar niet per sé, ze willen zelf het beste. Geef mij bijvoorbeeld dagelijks 5 auto's en op moment dat ik ze niet vul dan krijg ik boete. Op dit moment zijn er vaste transporteurs per bestemming, in plaats van flexibiliteit. Bij zo'n hub moet er ook iemand zijn die de keuringen regelt door de CSI. Dus als lossende boten 's nachts zijn; medewerker nodig die keuringen moet verzetten. Met transporteurs kijken hoe we met elkaar kunnen groeien door samenwerking. Nu zijn de kantoortijden 7 tot 6 en heb je 2 medewerkers die op de planning zitten (bijvoorbeeld door douane of door wachttijden; die moeten dan ook 's nachts oppakken), maar door samenwerking zou niet elk transportbedrijf dat hoeven.

21. What are the constraints of a hub with extended opening hours as a concept?

Empty depots zijn ook een probleem. Daar zijn de wachttijden soms 2/3 uur. En die zijn alleen overdag open. Het systeem Avontida (website als je naar andere plek je lege container retour wil doen; kost 125 euro per container om op een andere plek in te leveren volgens mij). Niet meer fijn voor transporteur. Empty depots zijn van rederijen (die zijn arrogant): aan de voorkant wordt een probleem veroorzaakt door rederijen die containers te veel aanleveren, dan raakt de terminal vol (te weinig capaciteit). En aan de achterkant kan je lege containers niet kwijt (door geen flexibiliteit rederijen): er komen alleen maar kosten bij. Door de wachttijden kan je maar 2 containers op een dag ipv 3 containers vervoeren. Daarnaast staat op de RWG terminal een duane scan die al maanden kapot is. Dus moet je extern scannen, dat vertraagt het proces. Het havenbedrijf (rol met douane) moet actie nemen. Van rederijen is het nodig dat empty depots op andere tijden open zijn: laat in de middag pas container terug. Én als een container voor de deur in weekend moet blijven staan zijn de eerste ritten

de volgende dag in gedrang. De terminal is wel 24 uur open maar er zijn pauzes (ECT, delta, de oudere terminals) waarbij ze gewoon bijna een uur onbereikbaar zijn. Dat werkt net precies niet. Een chauffeur moet dus altijd ervoor zorgen dat hij net voor de pauze op de terminal is. De pauzes zijn vast. Vakbonden hebben die pauzes geregeld; moet op een andere manier.

22. How do you think these constraints could be relaxed?

Door een terrein goed inrichten: verharden om er met auto's te komen. De ervaring is dat meerdere partijen moeilijk om oplossing te vinden dan invidueel. Dat op ECT city was een individuele afspraak. Dat ging veel makkelijker dan praatgroepjes. Welke locatie? Botlek? Barendrecht? We kijken naar schaal vergroting als oplossing . Andere partij met andere transporteurs rijdt; samengaan. En dan flexibel aan transporteurs: welke containers willen jullie rijden? Hub creëren in Venlo zodat de containers hier blijven

23. Do you think using a hub with extended opening hours would add/reduce costs/benefits for you and why?

Denk iedereen interressant maar straks te groot: te veel ontvangers en transporteurs. Daar weer discussie; wie mogen er mee doen? Het probleem is te groot. Wij hebben jaren geleden (oude ECT) door automatisering: reefer containers worden apart gezet: niet aangesloten (overleg klant): wij containers ophalen wanneer we wilden en lege inleveren: veel sneller. Maar nu met automatiseren: flexibiliteit weg. Interne hubs op terminals kan nu niet meer door automatisering

G.4.2. Freight forwarder B

General questions about company and processes:
1. What service do you give as a company?

Wij zijn een logistieke dienstverlener in temperatuur gekoelde goederen wereldwijd (voedsel gerelateerde producten). We vervoeren van bananen tot tonijn. In Nederland hebben we 5 Distributie centra en 1 logistieke dienstverlener. In ons DC in Urk krijgen we 180 export containers per maand. We hebben geen eigen wielen, maar we zijn een expeditor (forwarder). We regelen vervoer namens opdrachtgevers container haulage pakket. Veel export doen we ook. 80% doen we via onze warehouse, 20% gaat direct naar retailers DC's of zelfs Nederland uit.

2. How do you interact with carriers, receivers, terminals, hubs?

Het meeste gaat via geautomatiseerde informatiesystemen. Op het moment dat een container vertrekt in China: wat is er ingeladen? Dan pro forma planning: als schip dichter bij dan scopen wij via Portbase de stand van het schip. Als het schip aangemeld wordt; de op terminal verwachte aankomst- en vertrektijd. Dan afgestemd met klanten. Met ene klant 2, andere klant 3 dagen om terminals op te halen. Wij hebben geen planners 's nachts zitten. Eigen tijdsplanning per klant voor wanneer ze daar moeten zijn. Wij geven tijdsloten aan vervoerders (wanneer container waar moet zijn; aan de vervoerder wanneer die opgehaald moet).

3. How do you set-up your contracts with shippers?

We hebben ten minste jaar afspraken (minimaal een seizoen voor eten), maar ook 3-5 jaar afspraken/contracten. Prijzen staan vast per container. Het variabel gedeelte van de prijs is; de diesel, het type terminal en de wachttijden. Als er wachttijden ontstaan dan hebben we een vast bedrag per uur met vervoerders en per klanten: maar wat zijn de bewijslasten? En we hebben een prijs met vervoerders gebaseerd op round trips (ook demerge and detention kosten). Voor vervoerders hebben wij jaarafspraken of seizoens. We hebben meerdere vervoerders (ongeveer 5 verschillende). Die hebben dezelfde vormen van contracten. Speciale containers laten we regelen door vaste vervoerders.

4. Do you collaborate with other freight forwarders?

Ja soms regelen wij ook dingen voor anderen die het te druk hebben.

Questions on waiting times at container terminals:
5. Do you perceive waiting times at terminal gates' in the port of Rotterdam and how?

Ja, maar die wil je helemaal niet.

6. What do you think is the reason for these waiting times?

DC's zijn open tussen 06:00 en 20:00. De duane, de NVWA, de rederijen; allemaal open tussen 06:00 en 20:00. De hele keten heeft kantoortijden. De duane doet niks 's nachts. Dus al het vervoer moet noodgedwongen overdag. Chauffeurs mogen soms legaal pas om 6 rijden.

7. What are the consequences of these waiting times for you as freight forwarder?

Het is voor de hele keten dramatisch. De vervoerder haalt zijn tijdslot niet. Wij staan te wachten bij een DC met mensen, bijvoorbeeld de keuringsmensen staan te wachten. Eerst gaf een rederij een container 5 tot 7 dagen vrij staan op een terminal. Nu 2 tot 3 dagen.

8. How do you think these waiting times could be mitigated?

Door het verbeterd afstemmen met wat komt er op ons af en waar blijft dat? Wat is de zekerheid dat 's nachts die container beschikbaar is?

9. Do your carriers perform night-time container transport at this moment and why?

In het hoogseizoen starten wij eerder. Reefercontainers maken veel geluid dus zijn vervelend in de nacht. En de terminal moet dan handmatig reefer afhandelen in plaats van automatisch. Regulier vervoeren wij daarom 's nachts niet (ook door de controlerende instanties). In het drukke seizoen wel: dan zijn er on top kosten (piek citrus, druiven). De NVWA werken maar van half 8 tot half 7, ergens op de Maasvlakte. De rest komt ook tijdens kantoortijden langs op je DC. We werken sowieso op zaterdag, net als de andere vrieshuizen.

10. Do you think night-time transport (would) add/reduce costs/benefits for you and why?

In de nacht vervoeren is duurder (CAO is 's nachts aanzienlijk duurder en je mag minder uren rijden) dus ik denk nu niet meer efficiency voor de vervoerder. Alleen minder wachttijden en minder file: dus dat gedeelte is juist wel productiever. Nu halen wij wel al in avondblok reefer containers naar Maasvlakte.

11. What are the constraints of night-time container transport?

De kosten dus. En de handigheid van minder uren rijden.

12. How do you think these constraints could be relaxed?

Je hebt vervoerders die een eigen ruimte hebben; die eigen terrein hebben in Rotterdam Zuid die dat weer uitgeven aan vervoerders om te gebruiken. Je kunt ook een abbonneent afsluiten op Maasvalkte plaza.

13. Who makes what decisions about the route scheduling of a container and how?

Wij, de klant zegt alleen of het een prioriteitlading is. Wij halen de container eerder op als iets nog verpakt moet worden in een van onze distributie centra. Dan gaan ze eerst nog daar langs en daarna naar de klant.

14. What type of hub do you think this should be if implemented and why?

Barge kan de oplossing zijn. Maar in Nederland is er geen water aangesloten aan vers bedrijven. Bij frozen producten: die moeten langs het NVWA keurpunt en die zitten niet aan het water, 's nachts haal je ze op maar dat gebeurt niet . De trein is niet aangesloten want voorbij Duisburg is er geen aansluiting.

15. What are the constraints of a hub with extended opening hours as a concept?

Het moeilijkste bij onze reefercontainers is dus dat die gekeurd moeten worden dus dat is wel een probleem.

16. How do you think these constraints could be relaxed?

Voor droge containers zou het beter werken. En bananen hoeven niet per se gekeurd te worden.

G.5. The Port of Rotterdam

Questions on waiting times at container terminals:

1. Do you perceive the waiting times for trucks at terminal gates' in the port of Rotterdam as a problem and if yes, how?

Goeie vraag, aan de ene kant kan je zeggen dat het geen echt probleem want het is niet erger dan bijvoorbeeld in Antwerpen. Aan de andere kant kan je zeggen dat er wel uitdagingen zijn. Bijvoorbeeld tijdens bepaalde gewilde tijden van een appointment systeem. Voor vervoerders kunnen de wachttijden wel vervelend zijn. Maar het is pas echt een probleem voor de haven als de containers niet kunnen worden uitgehaald of als de vertraging echt héél lang wordt en het bijvoorbeeld dagen duurt om een plek te boeken. Op dit moment kunnen er gewoon nog afspraken gemaakt worden, dus er zijn nog niet echt (grote) problemen. Maar voor een efficiënte haven duurt het wel te lang, dus er is wel een uitdaging.

2. What do you think is the reason for these waiting times for trucks?

De reden voor de wachttijden is dat bepaalde tijden gewilder zijn dan anderen. Dit komt niet door de vervoerder maar door de verlader en verscheper die op bepaalde tijden hun vervoer willen ontvangen en laten vertrekken.

3. What are the consequences of these waiting times?

De gevolgen van de wachttijden bij de terminals zijn files en dat is natuurlijk suboptimaal. Ook zijn er extra kosten door bepaalde actoren. Als deze hoger zijn dan voor andere havens dan heeft de haven van Rotterdam een concurrentie nadeel. Het is slecht voor ons als verladers ervoor kiezen om naar Antwerpen te gaan omdat de kosten, door wachttijden, daar lager zijn. Ja ook emissies is inderdaad ook een nadelig gevolg.

4. How do you think these waiting times could be mitigated?

Ten eerste door het aantrekkelijker maken van andere modaliteiten, dus meer vervoer naar de binnenvaartschepen en treinen. Daarnaast meer duidelijkheid over de beschikbaarheid van terminals (door de slot boeking systemen). En ook door de pieken af te vlakken, dus meer vervoer naar bijvoorbeeld de nacht. Als laatste zou je nog kunnen zeggen dat terminals hun capaciteit kunnen vergroten, door bijvoorbeeld het aantal gates te verhogen.

5. What are the constraints of night-time container transport?

Dat de ontvangers en verschepers niet open zijn in de nacht. Vervoerders werken vaak 16 uur, maar distributie centra zijn maar 12 uur open. Daarnaast is er ook nog het personeelsvraagstuk. Aangezien er nu een personeelstekort is, kan het moeilijk zijn om iemand te vinden die in de nacht wil rijden en die bijvoorbeeld bij de distributie centra in de nacht willen werken. Depots zijn inderdaad ook niet altijd 's nachts open maar die zijn niet echt het probleem, aangezien sommige wel open zijn en die tijden misschien wel zouden veranderen als ontvangers en verschepers wel in de nacht zouden willen vervoeren en vervoer aannemen.

6. How do you think these constraints could be relaxed?

Als ontvangers en verschepers toch 's nachts open kunnen zijn, maar dat is moeilijk. Of je moet het 's nachts op een andere werkwijze aanpakken. Zoals inderdaad een hub die 's nachts open is. Of ergens op een terrein van een ontvanger of vervoerder de sleutel krijgen en dat containers daar 's nachts neergezet worden.

7. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?

Persoonlijk denk ik dat het maatwerk vraagt. Dus moet je per eindbestemming kijken wat de beste oplossing zou zijn. De uitdagingen in Venlo zijn bijvoorbeeld anders dan in Delft. Als er ergens veel volume heen gaat, zou daar bijvoorbeeld een hub een goede oplossing zijn. Maar als er ergens niet heel veel containers naar toe gaan kan een chassis-exchange mogelijk een oplossing zijn. Of als er ergens lokaal al opties zijn van bestaande ruimte bij ontvangers of vervoerders, kan dat natuurlijk een oplossing zijn. Een chassis-exchange bij de terminals lost eigenlijk (ook) een ander probleem op. Namelijk het personeelsprobleem voor kleinere vervoerders. Die hebben namelijk weinig personeel maar hebben ook te maken met de rust wetgeving. Deze kleine vervoerders hebben vaak geen eigen terrein. Dan kan zo'n chassis-exchange ervoor zorgen dat zij 's nachts een container daar kunnen zetten (in plaats van op een eigen terrein) en dan kan een van hun chauffeurs hem de dag erna naar de eind bestemming brengen. De verantwoordelijkheid van de container speelt ook een grote rol. Als de

containers 's nachts bijvoorbeeld op het terrein bij een vervoerder of ontvanger staan: wie is dan verantwoordelijk voor de veiligheid van de container? Wie wil dat doen? Bij een hub op chassis-exchange is dat duidelijk. Dan is het gewoon de hub of exchange, en dan betaal je daar extra kosten voor. Dan is de verantwoordelijkheid dus makkelijker geregeld, maar zijn de kosten wel weer hoger.

8. Are there benefits of a hub with extended opening hours and if yes, what?
Dat containers 's nachts vervoerd kunnen worden, zonder dat ontvangers/DCs 's nachts open hoeven te zijn of vervoerders zelf een terrein moeten hebben met containers.

9. What are the constraints of a hub with extended opening hours?
Het bedieningsgebied van zo'n hub. Je wil een hub die zo flexibel mogelijk is in de aantallen containers. Wil je een hub voor alleen Delft, of 1 hub voor heel Zuid-Holland? Is dat dan niet een terminal? De balans met aantallen containers is moeilijk want hoe dikker de stroom, hoe meer planbaar. Maar als de container stroom te groot wordt, krijg je ook files bij de hub. Maar als je dan weer een kleine stroom doet, is het dan wel kosten effectief? En de kosten, investeringen en de verantwoordelijkheid en veiligheid van de hub.

10. How do you think these constraints could be relaxed?
Door het lokaal per gebied te bekijken. En het is een business case. Als een privé partij inziet dat het er in een bepaalde plaats behoefte is aan zo'n hub, door te lange wachttijden en veel containers, kan deze een hub opzetten en daar het geld voor vragen wat actoren er dan voor over hebben om niet te wachten. Terminals hebben dit ook gedaan (zoals ECT in Venlo), zodat hun containers niet allemaal worden opgehaald in Rotterdam. Terminals zouden voor een betere spreiding waarschijnlijk wel wat zien in een hub and spoke systeem van terminals/hubs. Maar wel ook veel intermodaal. Misschien met trucks als je ergens bijvoorbeeld niet kan komen met een binnenvaartschip. Vervoerders of verladers kunnen in zo'n hub investeren als ze denken dat het handig is voor hen in een bepaalde regio (samen kosten bundelen). Vervoerders die een landelijke/regionale dekking hebben zullen waarschijnlijk niet gaan investeren in Dordrecht ofzo. Maar bepaalde ladingstromen in bepaalde regio's zouden wel geschikt kunnen zijn. Zoals bijvoorbeeld in Alphen aan de Rijn, waar een Barge terminal is gekomen voor Heineken en Zeeman die daar zaten. Een private partij zag de kans en heeft deze gebouwd omdat het een goede business-case was. Je zou zoals Plaza op de Maasvlakte een trailerpark kunnen maken in het achterland waar chauffeurs ook kunnen slapen, maar wie zou dit betalen? Je zou eventueel bestaande Barge hubs kunnen gebruiken als vrachtwagen hub. Gewoon dat terrein gebruiken zonder dat ze met binnenvaartschepen gaan. Bestaanbare hubs of maatwerk bij ontvangers of vervoerders zijn haalbaarder dan aparte hubs.

11. Do you think you would possibly subsidize a hub with extended opening hours and how?
Op dit moment is dat lastig aangezien beide partijen vooral investeren in andere modaliteiten dan vrachtwagens, dus in bijvoorbeeld intermodale hubs. Als de vrachtwagens écht een groot probleem zouden zijn, zou de markt wel zorgen dat andere modaliteiten meer gebruikt worden. Nu is het aandeel van de trucks alleen nog maar aan het stijgen. Dus blijkbaar is het nog steeds een betrouwbare modaliteit. Ook zouden lokale ondernemers een business case zien voor hubs als het echt een groot probleem was. Het is pas erg voor de haven als containers niet meer kunnen worden opgehaald. Het belangrijkste voor het Havenbedrijf is de concurrentiepositie van de haven en het achterland. Pas als de containers naar Antwerpen zouden gaan is het een probleem. Nu zou het Havenbedrijf waarschijnlijk nog niet investeren in zo'n concept. Alleen in Alblasserdam heeft het Havenbedrijf geïnvesteerd, omdat de A15 op de schop ging en het anders echt mis leek te gaan. Uiteindelijk viel dat allemaal tegen. Ook het ministerie van IW zal dit waarschijnlijk niet doen omdat ze focussen op andere modaliteiten. De provinciale overheid zouden het belang moeten inzien van zo'n hub.

G.6. The Ministry of Infrastructure and Water Management

Questions on waiting times at container terminals:

1. Do you perceive the waiting times for trucks at terminal gates' in the port of Rotterdam as a problem and if yes, how?
Ja is een probleem. Wij zijn van de BV Nederland. Alles is om logistieke goederenvervoer zo efficiënt mogelijk te krijgen. Goederenvervoer corridors zijn belangrijk op het moment (veel van Rotterdam naar andere plekken, zoals het oosten). Voor vervoerders een probleem (stilstaan, geld weggooien), vanaf duurzaamheid (stationair draaiende vrachtwagens), en de doorstroom. Je moet niet gokken op 1 modaliteit (binnenvaart/trein, maar ook truck). Daarbinnen geld wel dat wegennetwerk overvol is (bereikbaarheid knelpunten: files). Al jaren een beleid van modal shift (dikke internationale stromen via binnenvaart en goederenvervoer). Maar niet alles over spoor en binnenvaart; er blijft heel veel over voor het wegtransport. Bijvoorbeeld periode van lage waterstanden: dan kan er minder over binnenvaart maar meer naar weg. Dus alles moet

efficient zijn en alle modaliteiten nodig.

2. What do you think is the reason for these waiting times for trucks?
Organisatieprobleem: hoe organiseer je de container transport? Soms grote zeeschepen die aankomen. Het organiseren van deze planningen zijn erg complex. De overvolle wegen moeten beter gebruikt worden. Door bijvoorbeeld nacht rijden. De distributie centra waar ze heen moeten zijn 's nachts dicht. Ideaal gesproken moet je containers weg krijgen uit het havengebied. Waar moeten ze dan naar toe en hoe moet je dat faciliteren? Voor het ontvangen van containers 's nachts hoef je niet zoveel mensen te hebben. Wel krappe arbeidsmarkt (willen mensen wel 's nachts werken), maar mensen zijn altijd wel flexibel in de logistieke arbeidsmarkt.

3. What are the consequences of these waiting times?
Congestie, emissies, efficiency (voor vervoerders die verliezen geld door de wachttijden; moet het ministerie ook naar kijken). Aantrekkelijkheid? Ja uiteindelijk maakt dat ook wel uit ja. Rotterdam profileert zich heel erg als een betrouwbare partner, en dan zijn wachttijden wel een probleem. Antwerpen is een grote concurrent.

4. How do you think these waiting times could be mitigated?
Nacht vervoeren van containers en andere modaliteiten. Je hebt een bepaalde infrastructuur; opgegeven moment kan je niet meer uitbreiden: dus beter benutten infrastructuur (projecten verleden).

5. What are the constraints of night-time container transport?
Personeelsvraagstuk door krappe arbeidsmarkt (maar moet op zich wel lukken want zoveel personeel heb je niet nodig)

6. How do you think these constraints could be relaxed?
Je brengt mensen op ideeën door het vaker met mensen over dingen te hebben (triggeren van vervoerders en distributie centra). Door het veel over te praten dan weten ze dat ze niet de enige zijn die erover nadenken. Ontvangst van goederen is officieel overdrachtsmoment. Ontvangsten hebt je dus A) of mensen voor nodig die aftekenen, of B) ruimte met camera's voor ontvangstproces zonder mensen. Ontlasten containers in de haven rij je niet in de stad dus geen geluidsoverlast. Dedicated centrum waar hele hoop klanten gebruik van kunnen maken

7. What type of hub do you think this should be if implemented (chassis-exchange, container hub, place at receiver) and why?
Praat hierover met container vervoerders en kijk waar zij mee komen. Als zij belang hebben dan komen ze wel met ideeën.

8. Are there benefits of a hub with extended opening hours and if yes, what?
Ja want die terminals moeten stromen en containers snel weg. DC's niet laat open. Handig dat 1 punt alleen open hoeft te zijn s nachts en niet alle DC's.

9. What are the constraints of a hub with extended opening hours?
Extra handling in het proces. Wat doe je er dan mee? Die vrachtwagen blijft niet staan denk ik? Dus er komen extra kosten. Veiligheid/verantwoordelijk

10. How do you think these constraints could be relaxed?
Wie heeft hier belang bij? De haven van Rotterdam is hier heel erg bij gebaat dat die goederen niet vastlopen in de haven. Provincie kan er mogelijk bij voor het investeren. Voor het rijk / ministerie: nieuwe ideen zijn interessant: willen we volgen en soms investeren als het een interessante pilot is, maar we kijken per geval. Kans dat de ministerie gaat subsidieren wel kleine kans. Betalen mee aan die pilots als ministerie. Als jij grote logisitiek dienstverleners hebt met heel veel last: die zouden ook kunnen investeren. Ook de ontvangers. Als zij er grote belangen bij hebben. Altijd initiatiefnemer nodig: vaak partij die het grootste probleem heeft. Maar we kunnen elkaar natuurlijk opzoeken en nagaan wat het probleem is en wie er allemaal last van hebben. Je zult zien dat we een gedeeld belang over hebben. In dit geval moet iemand een initiatief nemen: het begint met enthousiasme en initiatief van die partijen. Je kunt dingen pragmatisch met elkaar bespreken en kijken hoe je vooruit.

11. Do you think you would possibly subsidize a hub with extended opening hours and how?
Wij zullen geen restricties gaan zetten op verplicht in de nacht rijden. Maar bijvoorbeeld programma van meer in de nacht rijden: toen kregen mensen die s nachts gingen rijden kregen beloning. Maar als je stopt dan valt het weer terug in oude patronen. Belonen is dus een instrument. Maar we kunnen meer nadenken met de provincies en logistieke actoren. Bepaalde

aanpassing van de infrastructuur zou in theorie kunnen (niet graag). Of provinciale overheid? Ministerie verantwoordelijk voor snelwegennet. Provinciale overheid verantwoordelijk voor provincie. We werken wel veel samen over de goederenvervoer corridors. Overheidspartijen zijn iets voorzichtiger (niet meteen geld gebruiken); je moet het goed oplossen door te kijken wie er in willen investeren (business case). Rijksoverheid heeft heleboel dingen die dingen co-financieren (dan weet je meteen hoe serieus partijen zijn over het idee. Gain sharing / inzet van het geld zit achteraan in het project: eerst kijken wat willen we nou en welke oplossing zien we? De verdeling wie betaalt wat moet je logisch tegenaan kijken. Als haven van Rotterdam bijvoorbeeld meeste baat heeft: meest