Traffic & Transport
Anna van Buerenplein 1
2595 DA Den Haag
P.O. Box 96800
2509 JE The Hague
The Netherlands

www.tno.nl

T +31 88 866 00 00

TNO report

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Reliability in port-hinterland interface

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Author(s)	Gerwin Zomer; Paul Tilanus en Maaike Snelder
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Summary

The main goal of the ToGRIP project is to develop a data-driven integrated traffic and logistics model that can be used to design interventions (executed by the Port, Road and other authorities) to combat travel time unreliability and to improve logistic operations.

Before designing possible logistics interventions, we first need to understand the logistics operational details and the underlying behaviour. Portbase provided transaction data on arrival of container vessels, containers discharged and the (planned) loading time of these containers onto hinterland transport modes for the period 2015-2017. TNO analysed these data, describing distribution patterns and time series analysis (shifting patterns over the years), and derived metrics like the dwell time of containers being discharged (time the container waits to get picked up after being unloaded from the vessel) and the call size of a vessel (number of containers being unloaded during a port visit). These metrics provide the basis for more in depth analysis, like the correlation between high call sizes and long dwell times.

In order to understand the logistics mechanism and behaviour behind these processes and patterns, we conducted interviews with eight experts in maritime container logistics. This revealed the sense of urgency when vessels arrive in Rotterdam, causes for longer dwell times, and organizational patterns in transport and dock planning.

This resulted in a number of conclusions on the major role of demurrage and detention conditions on the hinterland planning and execution, shifting distribution patterns over the day towards late afternoon peaks, and reasons for these upcoming late afternoon peaks in pick-up. Based on these findings and insights, we provided recommendations for further in-depth analysis combining terminal process data and truck movement data and provided suggestions for a use case approach in the project involving conditioned reefer transport companies to feed and validate this in-depth analysis.

Contents

1 Introduction

1.1 ToGRIP

This report is part of the ToGRIP project. The objective of ToGRIP is to study the short and mid-term dynamics of logistic and traffic systems and the complex interrelations between these by using an extensive amount of data and by using novel data filtering, fusion and pattern recognition methods.

The main goal of the project is to develop a data-driven integrated traffic and logistics model that can be used to design interventions (executed by the Port, Road and other authorities) to combat travel time unreliability and to improve logistic operations.

1.2 Understand port-hinterland logistics

In order to design possible logistics interventions, we first need to understand the logistics operational details and the underlying behaviour. We started with a data analysis of the key terminal processes: For incoming containers, this includes the arrival time of the (ocean vessel carrying the) containers at the terminal, the discharge time of the containers to be unloaded, and the loading times of the container onto a hinterland transport mode. For outgoing containers, the process is the other way round: The unloading times by inland transport modes, the loading times (when the container lifted onto the ocean vessel), and the departure time of the (ocean vessel carrying the) containers.

These container hinterland movements by road contribute to traffic intensity on the road infrastructure network in and around the port: N15/A5 and Ringroads Rotterdam (A4/A15/A16/A20), thus also to congestion levels. The data analysis aims to better understand this link. This includes analyzing distribution patterns, effect of bigger call sizes, terminal characteristics, introduction of slot planning, preferences in container treatment, related to type of container (20/30/40 ft; reefer, high cube), cooling temperature in case of reefers, type of commodity etc.

Next, we want to understand the logistics mechanism and behaviour behind these processes and patterns, and that is the key subject of this report. Therefore, we developed a questionnaire and conducted interviews with experts. This was fed by and supported by desk research, focusing on the value of reliability in containerised maritime transport chains.

2 Analysis of container terminal data

2.1 Portbase container transaction data

There is an obvious link between port logistics data and freight traffic management data. A substantial part of the containers being unloaded in container terminals in Rotterdam leave the terminals via trucks to its destination. This freight traffic constitutes a substantial part of the traffic on the ringroads of Rotterdam (A15/N15/A4/A16/A20).

For the purpose of ToGRIP, Portbase provided transaction data on arrival of container vessels, containers discharged and the (planned) loading time of these containers onto hinterland transport modes for a subsequent number of years. The same data was also provided for outgoing containers.

TNO analysed these data in order to perform basic statistics and describe some standard patterns, like:

- Distribution patterns (of vessel arrivals or truck loadings over the day, per day of the week or per terminal);
- Time series analysis (shifting patterns over the years).

But we also derived a number of metrics from this data:

- The dwell time indication of containers being discharged (time the container waits to get picked up after being unloaded from the vessel)
- The call size of a vessel (number of containers being unloaded during a port visit)

These metrics provide the basis for more in depth analysis: time series analysis and distribution patterns for a subset of containers being unloaded from vessels with a very high call size, or correlation between high call sizes and long dwell times.

2.2 Some key findings

The analysis provided some interesting findings.

The average dwell time appears to rise, the figure below shows how the time between vessel arrival and loading onto hinterland truck increases from less than 66 hours in 2015 to more than 75 hours in 2018, an increase by 14%.
This is probably caused by the overall increase in transhipment (more occupied stacks and higher stacking height) and an increase in average call size. The latter is subject to particular analysis. Note that negative duration is explained by the use of expected loading times, whilst the vessel's actual time of arrival was delayed without updating the expected hinterland loading times of the corresponding containers. Moreover, for some terminals the actual loading time is not received by the Portbase system, and a "placeholder" hinterland appointment is made. This appointment is not always accurate, especially if there is no strict time slot management. The peaks at 00:00 and 12:00 are also symptoms of that behavior.

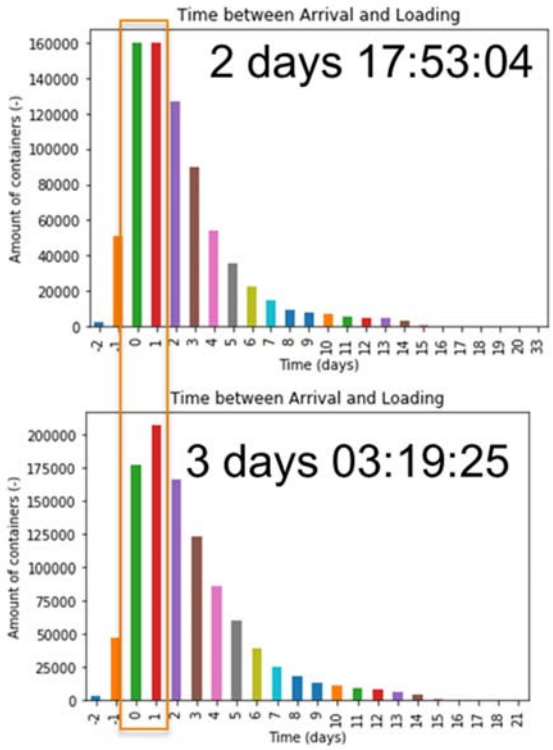

Figure 1: Container dwell times in 2015 (above) and 2017 in Rotterdam (below).

If we zoom in on the distribution pattern over the weekdays, we see that vessel arrivals peak on Tuesdays, discharge of corresponding containers peak a day later on Wednesday, whereas loading onto trucks is more equally spread over the working days, with marginal hinterland trucking movements in the weekend.

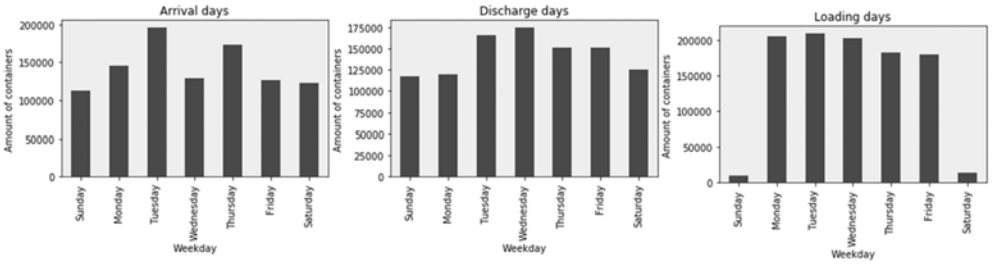

Figure 2: Distribution pattern over the week for container handling Rotterdam in 2017.

Loading distribution over the day shows the following pattern. The peaks at 00:00 hour and 12:00 hour are default values, and are expected to have in reality a frequency similar to the surrounding hours.

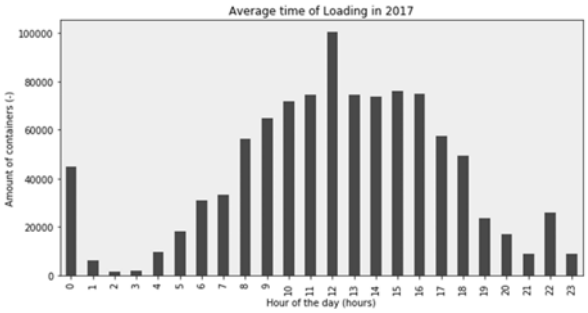

Figure 3: Distribution pattern over the day for container truck loading Rotterdam in 2017.

Striking is the peak in the late afternoon between 15:00 and 17:00. This is subject to more in-depth analysis.

Also, we see confirmation that average call sizes have grown. The share of small call sizes (200-300 TEU) becomes smaller, whereas call sizes between 700-1200 TEU seem to be replaced by a growing number of large call sizes (2000+ TEU).

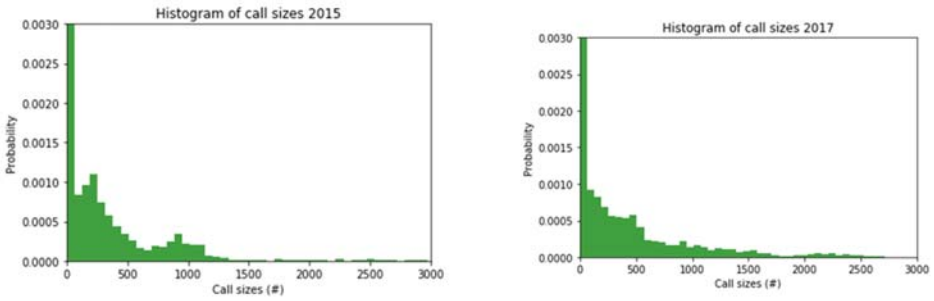

Figure 4: Call size distribution in Rotterdam in 2015 and 2017.

Not surprisingly, we see that average dwell time increases when call sizes become larger.

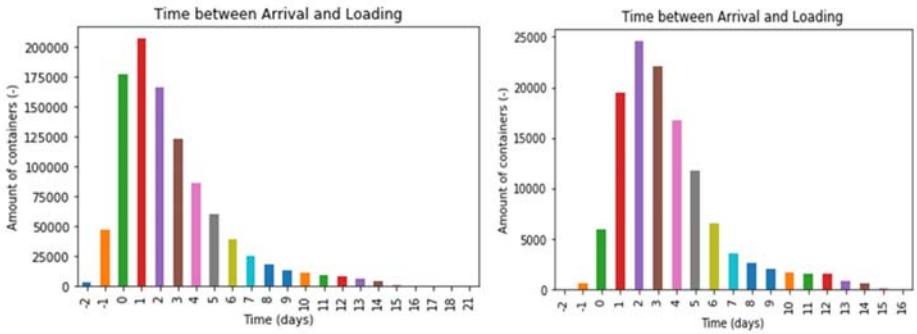

Figure 5: Container dwell time distribution in days in Rotterdam in 2017 for all arrivals (left) and arrivals with call size > 2000 TEU (right).

Some more in-depth analyses focus on the dwell times for particular containers. Containers carrying more weight, appear to have shorter dwell times. Also, the type of container matters; High cube 40 ft containers with gooseneck tunnel (type 45) have significant shorter dwell times compared to regular 20ft containers. There is also a striking difference between terminals. Whereas one terminal has an average dwell time of 70 hours, another terminal has an average of 97 hours. Also, the conditioning status appears to matter. For reefer containers, the colder the temperature, the longer the dwell time. This is explainable; Deep frozen cargo can be stored quite a while, whereas perishable goods often are being cooled to postpone the deterioration. But what is more striking and relevant for the scope of ToGRIP is the loading distribution over the day.

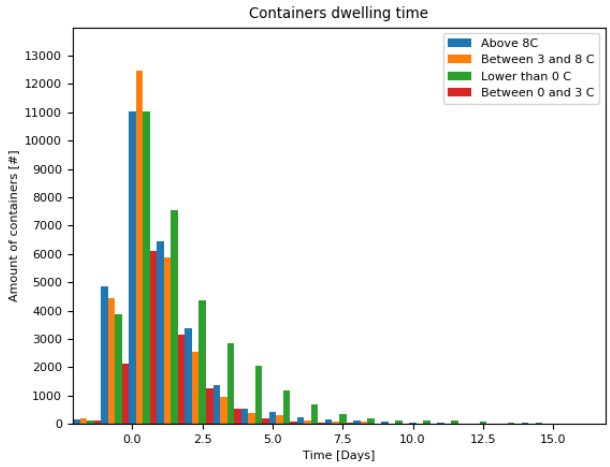

Figure 6: Container dwell time distribution in days for refrigerated containers in Rotterdam in 2017.

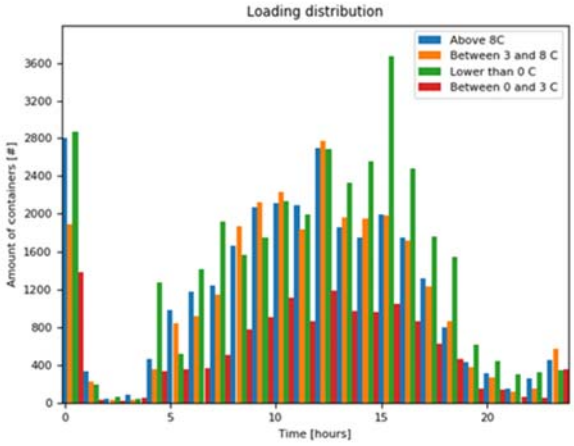

Figure 7: Distribution pattern over the day for reefer container truck loading Rotterdam in 2017.

There appears to be a peak in the late afternoon for loading of cold storage frozen goods, which is not obvious given the relative long dwell time of this type of containers. Note, the truck loading peak at 00:00 at night does not reflect reality. This is caused by a default value in the underlying databases. If no value was specified, the system logs 00:00 as value.

3 Reliability in port-hinterland interface

3.1 The port – hinterland interface

3.1.1 Incoming containerised goods transport

Transport is a derived demand from trade. The basis for a container movement is a contract of carriage, negotiated between buyer and seller. In the contract of carriage, the buyer and seller agree upon the price, delivery conditions and Incoterms. The agreed Incoterms define how the goods are being transferred between buyer and seller. Incoterms rules are intended primarily to clearly communicate the tasks, costs, and risks associated with the global or international transportation and delivery of goods.

The majority of global freight uses maritime transport as main leg (port-to-port) and containerisation still continues to rise. For incoming containers, some key logistics milestones include the arrival of the (ocean vessel carrying the) containers at the berth, the discharging or unloading of the containers, and the loading of the container onto a hinterland transport mode. These milestones are being captured and the corresponding transaction data including time stamps has been made available to the project by Portbase, the Port Community System of Rotterdam.

3.1.2 Outgoing containerised goods transport

For outgoing containers, the process is the other way round: Unloading the export containers by inland transport modes at the sea terminal, loading them on board of the ocean vessel and departure of the ocean vessel. Again, the corresponding time stamps have been captured and made available for analysis.

3.1.3 Congestion in landside container handling in ports

Economies of scale in maritime container transport has led to alliances of ocean carriers sailing with mega-ships between continents carrying up to 22.000 TEU, exchanging up to 7000-8000 moves in the major ports. As a consequence, feeder volumes have also shown a strong increase in major ports like Rotterdam, not only in absolute terms but also in relative terms (compared to deepsea volumes). And more than half of the barge volume needs to be handled at the same quay as deepsea and feeder vessels. Shipping lines are the most consolidated of all players in the logistics chain, are the paying customers for the process in the port and operate expensive assets; this gives them (negotiation) power and priority over respectively feeders and barges at the terminal. And since there is no contractual relationship between barge operators and deepsea terminals, there are no binding agreements on an operational level, resulting in delayed arrival times of deepsea vessels and no shows from barges. Lack of (service level) agreements leave the possibility at both sides to cancel or reschedule last minute without any financial consequences.

This situation results in serious congestion problems in the hinterland transport, mainly via barges. Contract terms from shipping lines regarding pickup / drop-off windows of containers (free turnaround time) became more stringent, limiting the time available to handle barges. Inland waterway transport of export containers is being planned against container closing times.

This is the time the container has to be at the sea terminal in order to catch its connection with the planned deepsea vessel. Closing times are 24 hours before arrival of the deepsea vessel. An alternative procedure is offered for containers being late. These have to submit a Late Arrival Request (LAR), involving additional charges. LARs can be submitted up to 12 hours before the deepsea vessel arrival time.

Peak demand is often enhanced by significantly delayed deep-sea vessels – punctuality has not improved in recent years. Essentially, these developments are the consequence of efficiency improvements at shipping lines that create inefficiencies in other parts of the logistics chain.

Also, hinterland trucking experiences waiting times and congestion. A trucking company tries to plan a voyage to/from the port optimizing its assets by combining bookings. With the new deepsea terminals on MVII, this may implicate that a truck driver unloads an export container (or empty container) on terminal A and loads another import container (or empty container) on terminal B. Lack of reliability results in waiting times and missing time slots.

3.2 Pre-notifications, slot management, cargo closing times and late arrival requests

At APM Terminals Maasvlakte II (APMT MVII), APM Terminals Rotterdam and Rotterdam World Gateway (RWG) pre-notification via Portbase is the condition to pick up or deliver containers. You can also pre-notify your containers via Portbase at the ECT Delta, Euromax and Uniport. The TAR (Truck Appointment Reference) is automatically provided as feedback for each visit. The TAR provides access to the terminal, in combination with a completed pre-notification and the cargocard, identifying the truck driver.

At RWG, APMT MVII and APMTR , you request a slot time together with your pre-notification. This means that the time slot in which the truck can discharge or load is agreed in advance. Once the time slot has been arranged, the truck will gain guaranteed access to the terminal within this time slot. APM Terminals MVII operates with time slots that are 30 minutes long; a tolerance of 45 minutes before or after the slot time is permitted. This slot planning system allows the terminals to make optimum use of their available capacity.

Flexibility in opening hours may also help avoiding truck standing still in road congestion. This refers both to flexibility on the shipper side (e.g. factory location closing at 18:00, not allowing trucks to deliver in the evening) and deepsea terminals (allowing weekend pick up).

4 Interview findings

4.1 Interviewed experts

A combination of telephone interviews and face-to-face interviews have been held with experts from 8 companies involved in maritime container logistics.
Below are the names of the expert interviewed:

- Paul Remerink, Manager Forwarding Inbound & Customs at Cleve & Zonen B.V.
- Albert Douma, Supply Chain Project Manager at FrieslandCampina
- Tara de Graaf, Project Manager Customs Affairs at Kuehne + Nagel
- Paul Barendregt, Company Owner at Barendregt Compliance and Specialist in Fiscal Representation and VAT for Logistics Services Providers
- Jan van Eijk – Customs Manager EMEA at Quaker Chemical B.V.
- John Salemink, Manager Customs and Trade Affairs at Broekman Logistics
- Johan Vosbeek, Manager Global Distribution at DSM Nutritional Products Nederland B.V.
- Cok Vinke Managing Director Contargo B.V. and and Heleen Scharroo, Branch Manager Contargo Road Logistics.

4.2 Main findings

Understanding the sense of urgency in hinterland transport
It looks like nobody seems to care about containers in transit on open sea, but as soon as the deepsea vessel arrives in Rotterdam, telephone traffic rises and every container seems to be in a hurry. This is being recognized by the majority of the interviewees. From this moment on, the potential to influence increases, speeding up a deepsea vessel or its routing is out of the sphere of influence of all parties except the ocean carrier.

Moreover, the demurrage and detention conditions play a role in the urgency. These conditions often require one cannot afford long delays in the planned hinterland processes. If the hired containers arrive too late in the empty depot, detention fees up to 100 dollar per day will be invoiced. In some cases, the pipeline inventory of the receiving end customers and unexpected peaks in demand may cause urgency. Reefer containers often have tight detention/demurrage conditions, always causing pressure on fast hinterland release.

In managing this port-hinterland lead time, container release processes are a key factor. If the paperwork is not right, import or transit declarations cannot be lodged in time, authorizations (e.g. for fiscal representation or VAT reverse charging procedures) are not ready, and release from the terminal is being blocked.
Delay in the expected arrival time of ocean vessel may further enhance the sense of urgency. This is the case for transport of perishable goods, but also for inbound transportation of promotion items (e.g. barbecues in Intratuin discount brochure, promotion items).
Incoterms play a modest role. They determine the way of having influence on the operators involved in the hinterland processes. Quite often, buyers and sellers have limited understanding of the Incoterms, what may cause long dwell times in the terminal. For instance, Chinese shippers sending containerised goods to Europe

under DDP conditions, but forget that they are responsible for import declarations and lacking a fiscal representative in The Netherlands.

Average dwell times in the terminals
Regarding average dwell times of containers there appears to be substantial differences between terminals. It appears that fully automated terminals experience longer dwell times then semi-automatic terminals. Apparently, a high level of automation is not necessarily resulting in more efficient terminal processes. For the pick-up time is being determined by the importer or consignee, it is not up to the terminal operator.
For consignments containing several containers, all being unloaded/discharged from the same deepsea vessel, the first container often has urgency, whilst the others are being treated as call-of orders executed when needed, as long as the terminal operator does not charge for stacking duration (free stacking period) and demurrage and detention period allows for it. In general, smaller customers with smaller import volumes tend to catch up their containers soon after being discharged, whilst the larger shippers tend to wait a bit longer, as long as inventory levels and charges allow for.

Some differences in average dwell time between type of containers can be explained, whereas others cannot be easily explained. Reefer containers often have a limited dwell time, especially if there is shortage in generator sets to keep temperature low during stacking. Difference between 20ft and 40 ft cannot be explained easily. The container contents are in this case probably the important factor.

Distribution of truck pick-up and delivery over the day
Whereas the statistics show a quite evenly spread pattern over the day, some interviewees refer to peak intensity of truckers in the morning hours and at the end of the day. Several aspects are relevant in this respect. Many shippers and producers concentrate their inbound logistics in the morning hours and their outbound in the afternoon to balance the capacity of the expedition department over the day. That means that import containers have to be delivered at warehouses or production facilities in the morning. These transport bookings will either be picked up early in the morning when the terminals open, or they will already be picked up at the end of the day and driven to a parking / resting place / cross docking location in order to be delivered at the customer premises early next morning. In both cases, these peaks correspond with peaks in road congestion.
In parallel, most container road transport carriers try to plan a number of paid trips to and from the port throughout a working day of a truck driver, respecting the working hours and resting hour restrictions. For national hinterland transport orders, transport operators tend to plan for 3 pick-ups during the day, starting in the morning, and picking the third one at the end of the day.
This pattern would explain a more evenly distribution over the day, with relative smaller peaks in the beginning and end of the day.

According to some of the interviewees, slot management also contributes to more evenly distribution of truck arrivals. Trucks have to book available slots. In case of no shows, they cannot enter the terminal and have to request a new slot, which might mean they have to wait several hours.

Inter terminal truck movements seem to grow with the upcoming of new MVII-terminals. More trucks deliver a container on terminal X and load an import container onto another terminal in the same trip, one of the interviewees calls this ‘Rondje Maasvlakte’. This also has an impact on reliability. Delay at one terminal have a direct impact on respecting the slot time on another terminal and in case of no shows this results in requesting a new slot and enlarging the dwell time of that particular container.

Delivering export containers
Export containers are being booked at a container carrier, planned to be shipped on a scheduled departure of a (deepsea) vessel. The booking gets a closing time assigned, this is the latest time the container has to be delivered at the terminal with all accompanying documentation ready. This documentation includes among others the export declaration, VGM declaration (validated gross mass), security declaration / AMS filing. The cargo closing time (CCT) is 24 hours prior to the expected arrival of the vessel. Since the ETA is subject to change, the CCT is also dynamic. Visibility about up to date ETAs and corresponding Closing Times is however limited. Hinterland operators and freight forwarders need a proactive attitude to get access to latest information about ETAs and closing times.

Nevertheless, closing times are taken seriously, several terminals do not even allow truckers to enter the terminal if the closing time has passed. In some cases a request has to be submitted, telephone calls are being made and then the terminal may decide to allow the trucker to enter the terminal. In case the closing time is being passed, freight forwarders may reschedule the ocean booking and send the trucker to Antwerp instead, in cases this is the next port of call in the liner schedule of the ocean carrier.

In most cases, the closing time determines the hinterland planning. Intermodal operators allocate the transport mode assigned to the transport booking. If there is enough time, inland waterway transport can be considered. When the closing time gets close, (rail if possible) or road transport is often being considered.

All containers being loaded onto a vessel have the same closing time assigned, independent of the stowage sequence. The stowage plan determines which containers are being loaded first and last. The stowage plan may be updated several times before being fixed. Carriers seem to differentiate in offering flexibility to shippers, e.g. offering more flexibility for shippers with substantial slot capacity booked in advance.

According to the majority of the interviewees, postponing closing times would not create more added value. It is more a matter of planning. An exception is alternative treatment of closing times for LCL consolidators. For them, an extension of the closing time with another 6 hours, would allow them to better utilise the load factor of the container.

5 Conclusions and recommendations

5.1 Conclusions

Analysis of transaction data of key terminal processes reveals some interesting findings. The average dwell time of containers - the time between vessel arrival and loading onto hinterland truck – increased in last three years from 66 to 75 hours (+14%). Not surprisingly, we see that average dwell time increases when call sizes become larger. Containers carrying more weight, appear to have shorter dwell times. Also, the type of container matters; High cube 40 ft containers with gooseneck tunnel have significant shorter dwell times compared to regular 20ft containers. There is also a striking difference between terminals (e.g. 70 vs 97 hours). Finally, the conditioning status of reefer containers appears to matter; the colder the temperature, the longer the dwell time. But at the same time, there appears to be a peak in the late afternoon for loading of cold storage frozen goods, which is not obvious given the relative long dwell time of this type of containers. Moreover, this late afternoon peak appears to become more apparent throughout the years and especially in the new MVII-terminals.

When we ask subject matter experts about the phenomenon of port and hinterland processes of containerised transport, a number of topics are being highlighted and recognised. First, as soon as a deepsea vessel arrives in Rotterdam, communication explodes and a sense of urgency is being felt by consignees and freight forwarders. This is mainly caused by the agreed container demurrage and detention conditions, these actors try to avoid these fees by transporting the full container to its destination, stripping the container and returning the empty container in time n an agreed empty depot. In some cases, it is not only the tight demurrage/detention conditions, but the need for the cargo inside the container.

This need is high if:

- inventory levels are low and reaching a critical level
- it concerns inbound of items with high peak demand (e.g. promotion items)
- it concerns perishable goods, with fast value deterioration
- it concerns high value goods with substantial working capital

The pick-up time of import containers is being determined by the consignee or importer. Small consignees tend to pick up containers faster than large importers, especially when the consignment consists of several containers. In that case, the first container is being treated with urgency, whilst the others follow a more relaxed hinterland treatment.

The hinterland trucking companies try to combine paid trips towards Rotterdam (delivering export or empty containers) with paid return trips (moving import containers from the terminal to its hinterland destination. They can carry 2-3 TEU per trip. Interterminal transport is also increasing, trucking companies speak of ‘Rondje Maasvlakte’, visiting more than 1 terminal during their port visit. The planning department of these companies tries to combine several transport orders on a working day of a truck driver. This results in quite a good spread over the day.

The afternoon peak could be explained by the pattern of some shippers to treat inbound transport orders preferably in the (early) morning and outbound transport order in the afternoon. This pattern allows for optimal use of the dock facilities throughout the day. As a consequence, transport companies either pick up these ‘inbound’ containers early in the morning or in the late afternoon, in order to deliver them the next morning.

For export containers, the closing time determines the hinterland planning. If feasible, inland waterway transport is being considered. For LCL consolidators, postponement of closing times by 6 hours could improve their container fill rates and as a consequence their margins. For the others, it is more a matter of planning.

5.2 Recommendations

So what do these findings and insights mean? How can we build upon them in a project like ToGRIP, where we combine data from port processes with road transport user data? The following recommendations can be made.

- Focus on the containers being loaded in the late afternoon and try to link them with road transport movements. Try to find patterns in terminals, hinterland destinations, type of road carriers, customers, type of containers and preferably cargo.
- Select the inter terminal movements of trucking companies, and try to link them with the containers being moved and the hinterland origins and/or destinations of those containers. Try to identify patterns, waiting times, customers, type of containers, hinterland destinations etc.
- Focus on reefer container movements, try to link these containers with truck movements (conditioned transport) and find patterns. Concentrate on deep frozen containers being loaded onto trucks in the late afternoon and find patterns in transport companies, destinations and customers.

By linking port process data with road transport data, we may find striking patterns that allow us to draft concepts for alternative hinterland treatment. If we could relieve the pressure on the road network during congestion hours, without jeopardising the underlying logistics requirements, we could further optimise the port-hinterland system. Preferably, we track individual container journeys. Alternatively, we apply a number of filters on both the terminal data and the road transport data and compare the aggregated data from both sources to identify striking patterns.

In a use case approach, we could analyse the container journey of a number of containers being transported by collaborative road operators. We could ask them to understand the reason behind the operations and validate patterns from broader statistics.

6 Signature

The Hague, 17 June 2019

Paul Tilanus
Projectleader

TNO

Gerwin Zomer
Author