Fact-based study on the container barge supply chain in the Port of Rotterdam

6 March 2018

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Any person intending to read this report should first read this letter

Reliance Restricted 6 March 2018

Mr. M. van Doorn
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3002 AP
Rotterdam

Dear Sirs, Madams,

Container congestion in the Port of Rotterdam

In accordance with your instructions, we have performed the work set out in our Engagement Agreement dated 10 November 2017 between Havenbedrijf Roterdam N.V. and Parthenon-EY B.V. rebranded to EY-Parthenon B.V. on 1 January 2018 (the "Engagement Agreement") in connection with the proposed services to perform a research on the container barge supply chain.

Purpose of our report and restrictions on its use

This report was prepared on the specific instructions of the directors of Havenbedrijf Rotterdam N.V. solely for the purpose as described in the Engagement Agreement and the supporting presentation dated 25 October 2017 and should not be used or relied upon for any other purpose.

This report and its contents may not be quoted, referred to or shown to any other parties except as provided in the Engagement Agreement.

We accept no responsibility or liability to any person other than to Havenbedrijf Rotterdam N.V., or to such party covered by a reliance letter which we have mutually signed, and accordingly if such other persons choose to rely upon any of the contents of this report they do so at their own risk.

Nature and scope of the services

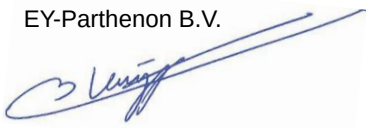
The nature and scope of the services, including the basis and limitations, are detailed in the Engagement Agreement. Moreover, not all data requested was or has been made available.

Whilst each part of our report addresses different aspects of the work we have agreed to perform, the entire report should be read for a full understanding of our findings and advice.

Our work commenced on 2 November 2018 and was completed on 1 February 2018. Therefore, our Report does not take account of events or circumstances arising after 1 February 2018 and we have no responsibility to update the report for such events or circumstances.

Yours faithfully,

EY-Parthenon B.V.



Bram Kuijpers
Partner

Background

- Congestion of container barges at deep sea terminals on the Maasvlakte is an increasing problem. This leads to an unreliable planning, additional costs and a reversed model split development. Upon request from the different stakeholders in the barge container logistics chain the Port of Rotterdam has been asked to take the lead in investigating the congestion problem

- However, identifying effective and supported solutions for the congestion problem is difficult as there is a variety of potential causes. Moreover, it remains difficult to distinguish fact and opinion and relative impact based on sometimes contrasting views of different stakeholders in the logistics chain

- The Port of Rotterdam and the members of the working group 1 have asked EY-Parthenon to:
  - Sketch the logistics chain of container barge transport, the power and contractual relations between the different players and relevant developments
  - Determine which of the root causes are valid and assess their respective contribution to congestion
  - Gather potential solutions and give a high-level estimate of their potential impact

- This report addresses the above three topics in summary. Please refer to the appendix for the extensive substantiation of the root causes analyses, more detail on potential solutions, and details on the process and basis of preparation of this report

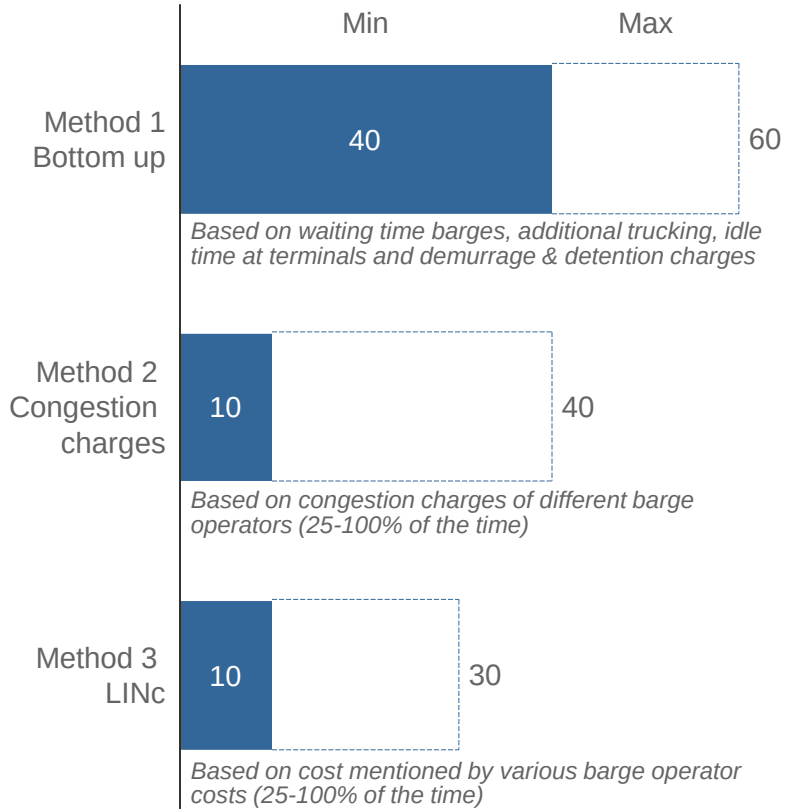
Container barge congestion in the Port of Rotterdam increased in the past few years

► **Development of time and volume in the Port of Rotterdam and associated congestion costs, 1998 – 2017**

Indicative

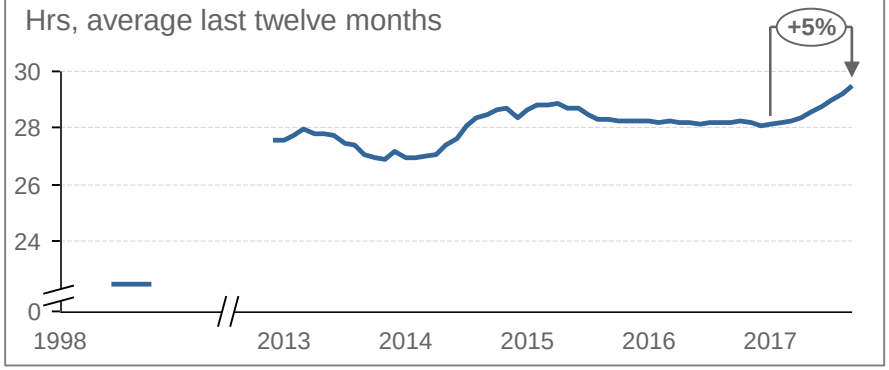
Estimate costs of congestion differ, yet are significant

Yearly congestion costs[1]
€m



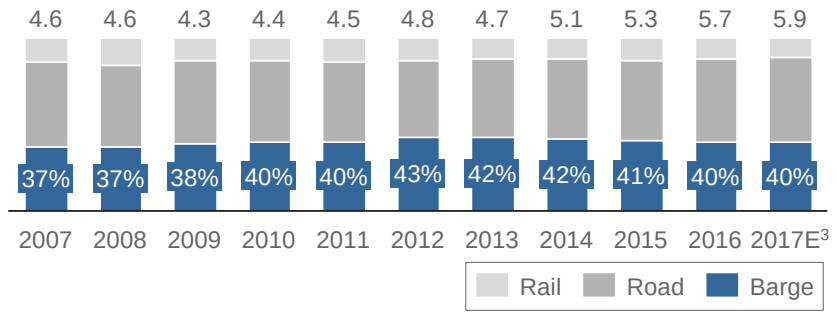
Time that barges spend within the Port of Rotterdam increased with 5% in the first 9 months of 2017

Average rotation time of container barges, 1998 – 2017[2]
Hrs, average last twelve months



Modal split is shifting away from barge

Hinterland transport at the Maasvlakte, 2007 – 2017E[3]
m TEU



1. Please refer to p.26-27 for detailed assumptions
2. Other source for 1998; based on average monthly rotations, not weighted by monthly voyages; new methodology since 2014
3. Based on the first half year of 2017

Source: Maritime Economics & Logistics; Stichting RIL; Inland operators; Port of Rotterdam; Press; Portbase; Interviews; EY-Parthenon analysis

Agenda

Context

The container logistics chain is complex with several trends leading to increased scale and complexity

► **Chapter summary**

- The container logistics chain is complex with a large number of players which may work together in different arrangements with the shipper being the paying end-customer; only in some cases shipping lines may have a direct relation with all parts of the logistics chain
- Deep sea terminals and barge operators work together but have no contractual relation, instead shipping lines contract and pay for barge handling at deep sea terminals; this leads to a lack of binding agreements on an operational level
- 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
- There have been several developments in the Port of Rotterdam leading to larger scale and complexity:
  - Container volume grows and deep sea vessels become larger
  - Consolidation and collaboration between the main container shipping lines increased, which is most likely to continue in the future
  - The Second Maasvlakte became operational with new terminals ramping up and room for further growth adding additional capacity, including additional barge handling infrastructure
  - More itineraries in the hinterland became available with newly build inland terminals
- Larger scale and (temporary) overcapacity at deep sea shipping lines and increased competition at deep sea terminals have led to lower costs in the value chain of which shippers are the main beneficiary

Context

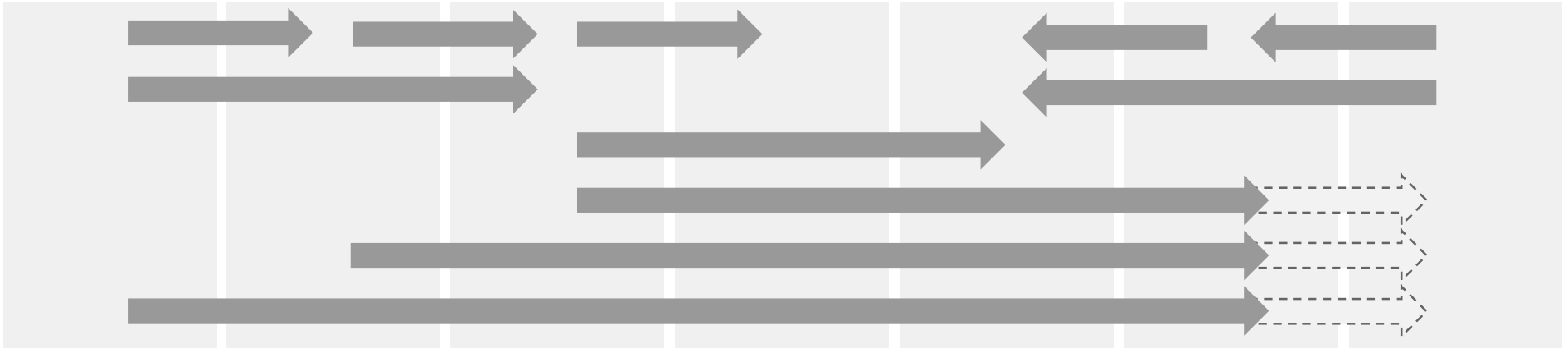
The container logistics chain is complex with a large number of players which may work together in different arrangements; only shipping lines have a relation with all players

- **Container logistics chain**

Typical responsibility

Shipper	Forwarder	Shipping line	Deep sea terminal	Barge	Barge operator	Inland terminal[1]
► Is owner of the shipped goods	► Organise the door-to-door transport for the shipper	► Operate the deep sea vessel ► May supply the container ► May contract hinterland transport	► (Un)load deep sea vessels and hinterland modalities	► Transport containers between terminals ► Typically not responsible for planning	*The majority of inland terminals take the role of barge operator as well[2]* ► Organise and plan inland barge transport	► Organise further inland transport ► (Un)load barges in the hinterland

Possible contractual relations



1. Note that there is not inland terminal role for the Rotterdam – Antwerp container flow, instead both end of the barge (operator) part are deep sea terminals
2. There are some independent barge operators without an inland terminal, a.o. Danser, Dubbelman, Prolog, and Barge Line Today

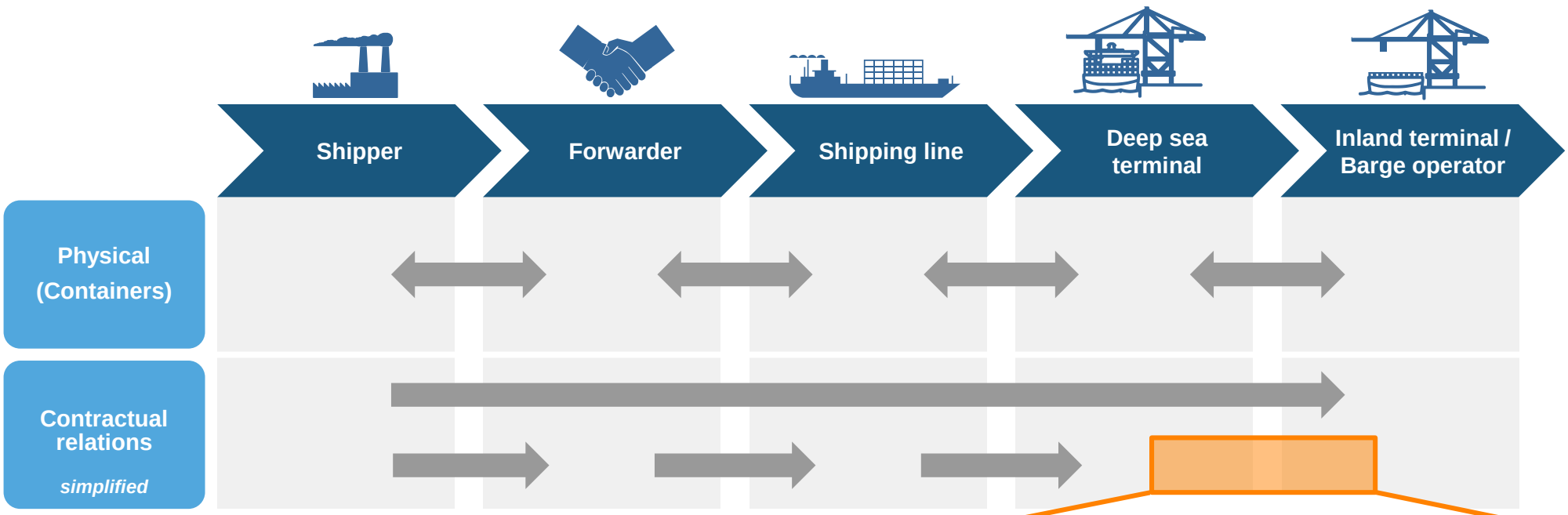
Source: Annual reports; Interviews, EY-Parthenon analysis

Context

Some players - such as deep sea terminals and barge operators - work together but have no contractual relation; this makes it more difficult to work together smoothly

► Logistics chain (simplified) – physical and contractual

Conceptual



Implications of absence of a contractual relation:

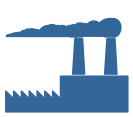
- Payment of the handling comes through the shipping line whose vessels often share capacity with barges; even shippers that contract hinterland transport do not have a direct relation with deep sea terminals
- Lack of (service level) agreements leave the possibility at both sides to cancel or reschedule last minute without any financial consequences

Source: Interviews; EY-Parthenon analysis

Context

Shipping lines are the most consolidated, the paying customer and operate expensive assets; this gives them strong (negotiation) power and priority at the terminal

► **Overview of players involved in the container logistics chain**






	Shipper	Forwarder	Shipping line	Deep sea terminal	Barge	Inland terminal / Barge operator
# of players[1]	~30,000 in NL >100,000 in DE ~20,000 in BE	>400 in NL >3,000 in DE >300 in BE	11 main operators	3 with 5 terminals	200 – 600 active barges with 150+ owners	NL: ~50 terminals with ~32 owners DE: ~40 terminals BE: ~20 terminals ~4 separate barge operators
Organised as	Associations, a.o. ► Evofenedex ► BDI/DSVK ► OTM ► SSC	Associations, a.o. ► Fenex ► SPEDLOGSWISS ► DSVL ► CEB	Organised in **3 large alliances** All alliance members are organised in the VRC	Association (VRTO)	Associations, a.o. ► BLN-Schuttevaer ► CBRB ► BDB ► EBU ► SVS	Associations, a.o. ► LINc ► VITO

Most inland terminals in the Netherlands function as barge operators. There are only a handful independent barge operators without an inland terminal

1. For shippers and forwarders the minimum number of players is based on member count of the associations representing them

Source: Annual reports; Interviews; Desk research; EY-Parthenon analysis

Context

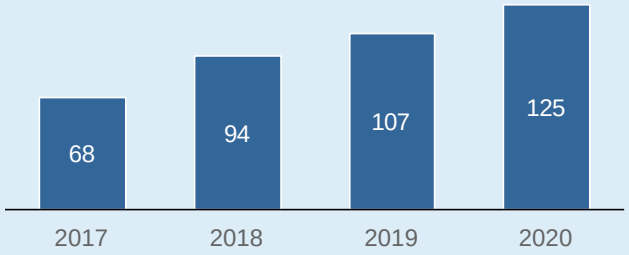
There have been several trends in Port of Rotterdam leading to larger scale and complexity

- **Examples of changes in the Port of Rotterdam**

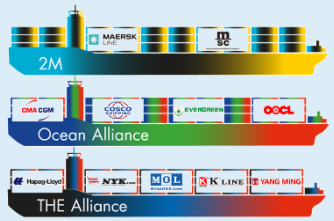
Not exhaustive

Container volume grows, transported by more and larger deep sea vessels

- **Estimated ULCV[1] counts of the 3 alliances, 2017 – 2020**
- # of vessels



Consolidation / collaboration of container shipping lines increases, this is likely to continue in the future



- New collaborations formed in April 2017 resulting in three alliances
- 3 Alliances combined have ~75% market shares

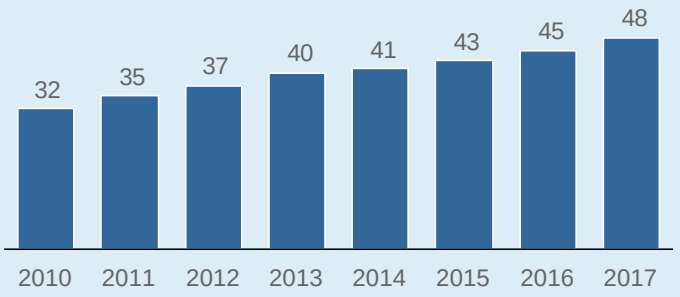
"Further consolidation seem imminent, most likely resulting in the survival of five or six top carriers"
– CEO Møller Mærsk

Maasvlakte 2 is operational with new terminals ramping up and room for further growth

- In 2015 the number of operational deep sea terminals increased from three to five
- Further growth is possible, APMT2, RWG and Euromax could all be further expanded

More hinterland itineraries are available

- **Inland terminals in the Netherlands, 2010 – 2017**
- # inland terminals



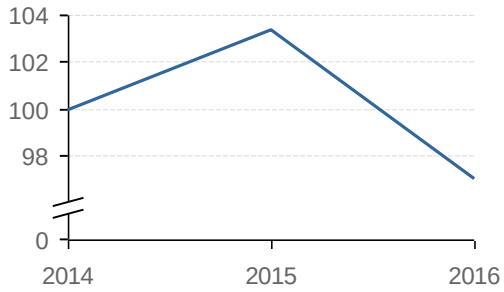
1. Ultra Large Container Vessels

Source: Port of Rotterdam; Inlandlinks; Press; EY-Parthenon analysis

Context

Larger scale and intensified competition has led to reduced costs of which shippers are the main beneficiary

- **Price development due to scale and intensified competition**

	Shipping line	Deep sea terminal	Inland terminal / Barge operator
Development that drives price down	► Increased scale of the vessels ► Increased operational efficiency with the new alliances ► (Temporary) overcapacity	► Increased competition with the opening of the Second Maasvlakte	► Increased competition due to higher density of inland terminals; partly competing with road transport ► Possibly, increased operational efficiency due to Rhine consolidation
Observations	**Asia – N-EUR spot rates** $k / FEU 	**DS Terminal Revenue per TEU[1]** Index (2014 = 100) 	"Increased competition in inland shipping has driven hinterland transport prices down" - Shipping line
Effected prices	► Ocean container freight rates	► Terminal handling charges (*delta may also be included in ocean container freight rates*)	► Prices for hinterland transport ► Inland terminals handling charges
Potential beneficiary	► **Shipper**	► **Shipper** ► Shipping line	► **Shipper** ► Barge operator

1. For selection of terminals

Source: Interviews; Annual reports; EY-Parthenon analysis

Agenda

Root causes

Although overall capacity is sufficient, increasing peak demand has put pressure on barge handling capacity

► **Chapter summary**

- Congestion at deep sea terminals is caused by increasing peak demand for barge handling, lower barge handling capacity during peaks and complex planning processes – the first two have driven an increase in congestion in recent years
  - Peak demand for barge handling has increased as a result of increased deep sea call sizes and tighter pick-up / drop-off windows; 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
  - At the same time, barge handling capacity has decreased at some deep sea terminals due to increased volume by feeders, which have a higher priority than barges, and possibly as a result of less cranes deployed
  - Planning for barges became more complex as new terminals opened. This effect is further enhanced since planning at deep sea terminals is not aligned across terminals; this drives congestion as it leads to inefficient barge routes and – as a result of no shows – inefficient use of handling capacity
- Increased number of inland terminals, increased overall volume through the Port of Rotterdam, changes in shipping alliances and opening times of inland terminals has no or limited impact on congestion, yet hinterland bundling could be a potential solution

- *Disclaimer:* The root causes for congestion have been validated as objectively as possible. Not all relevant data was available or has been made available by the relevant parties and therefore qualitative information was used as well. This also resulted in a lower degree of certainty for some root causes. For details on all the root causes, please refer to the appendix

Root causes

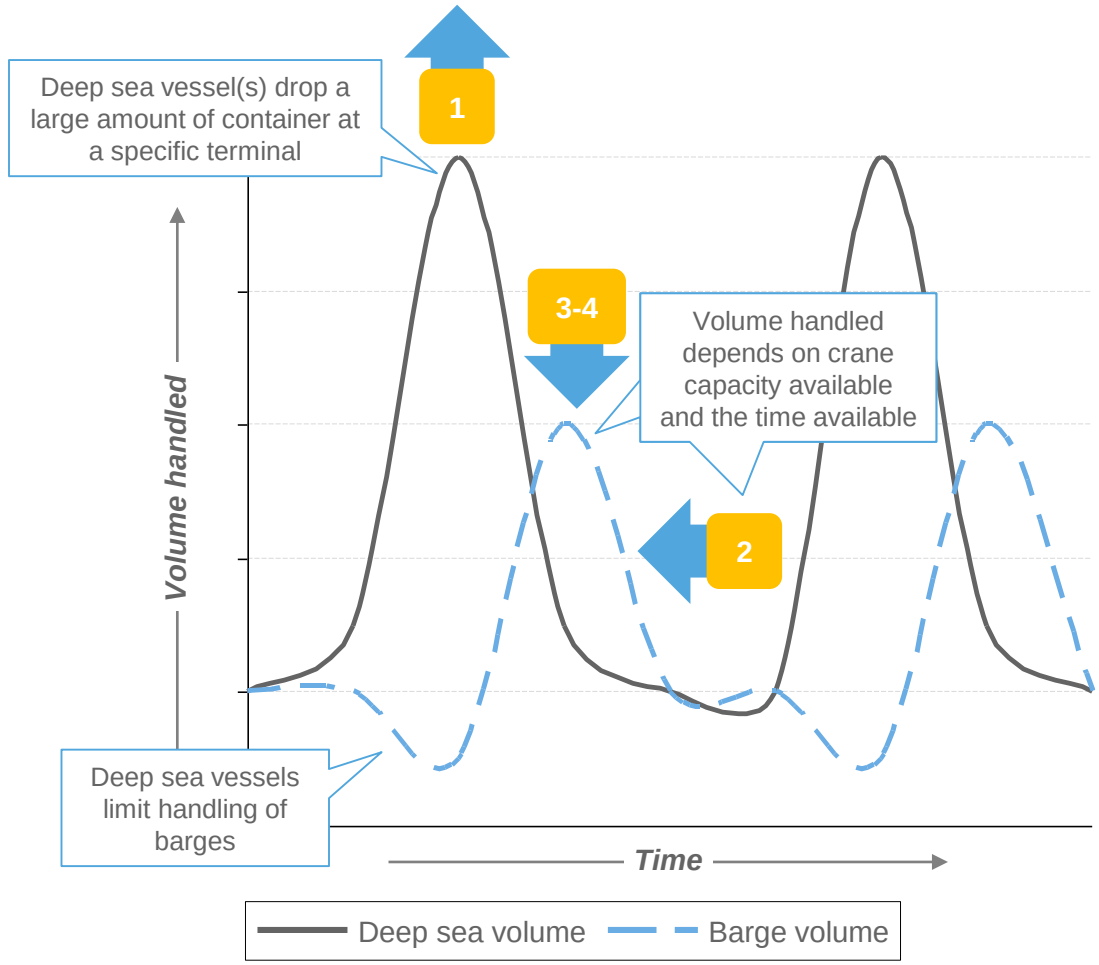
Multiple developments have jointly decrease relative capacity for barge handling during peak demand

Conceptual

Root causes

1. Increased size of deep sea ships led to larger **deep sea call sizes** driving peak demand upward
2. Contract terms from shipping lines regarding **pick-up / drop-off windows** of containers (free turnaround time) became more stringent, limiting the time available to handle barges
3. **Relative share of feeder activity** increased**,** limiting capacity available for barges at quay and crane
4. **Increased competition** between deep sea terminals has led to tighter capacity planning by terminals

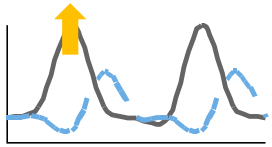
Simplified import example



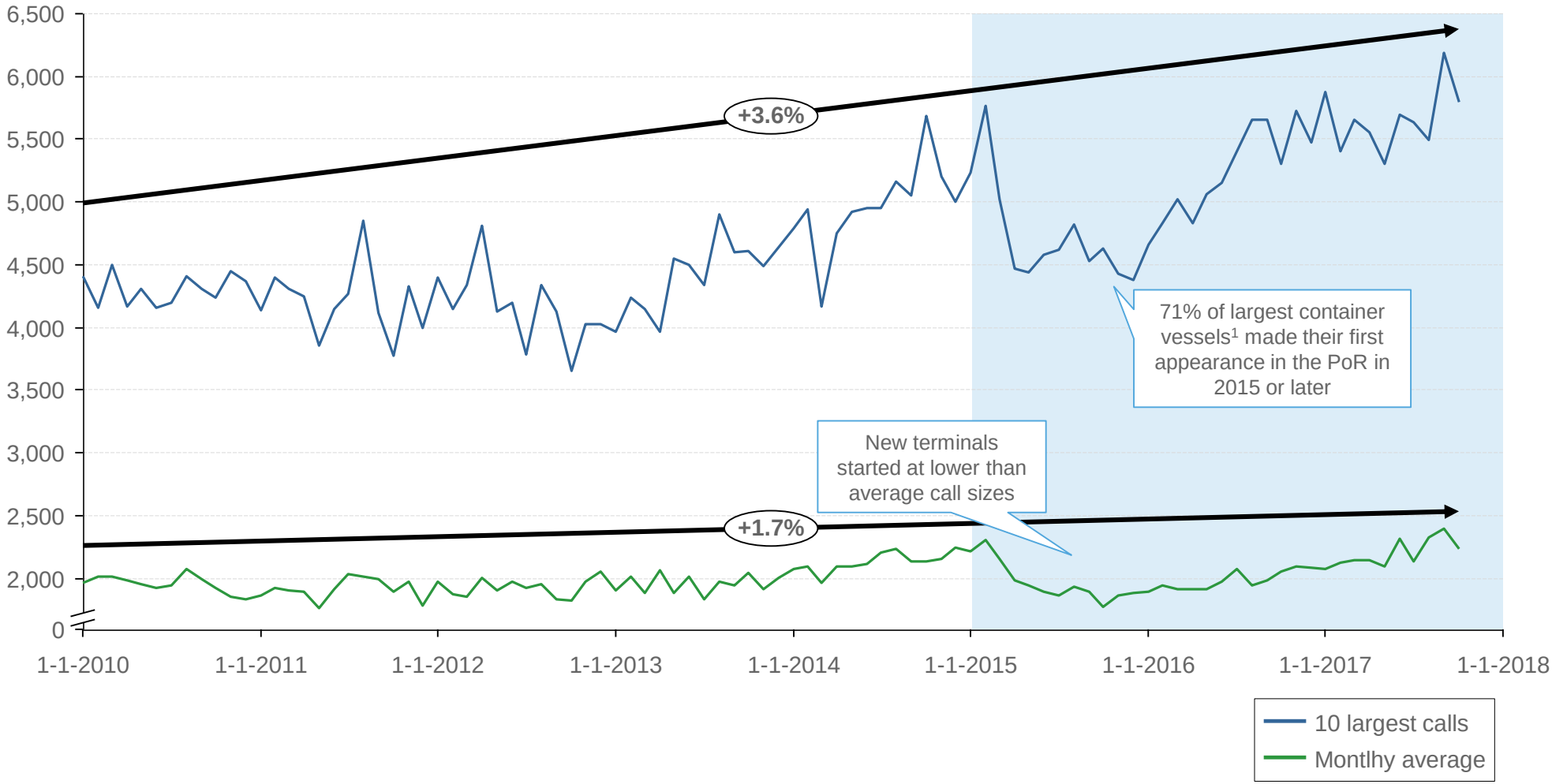
Root causes

Increased size of deep sea ships leads to larger deep sea call sizes

1 Deep sea call sizes



- **Monthly deep sea call size at DS Terminals, 2010 – present**
- # Containers per drop



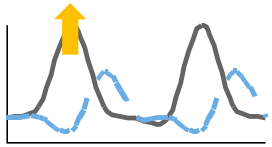
1. Defined here as vessels with length >394m

Source: Port of Rotterdam; EY-Parthenon analysis

Root causes

Peak demand is often enhanced by significantly delayed deep-sea vessels – punctuality has not improved in recent years

1 Deep sea call sizes

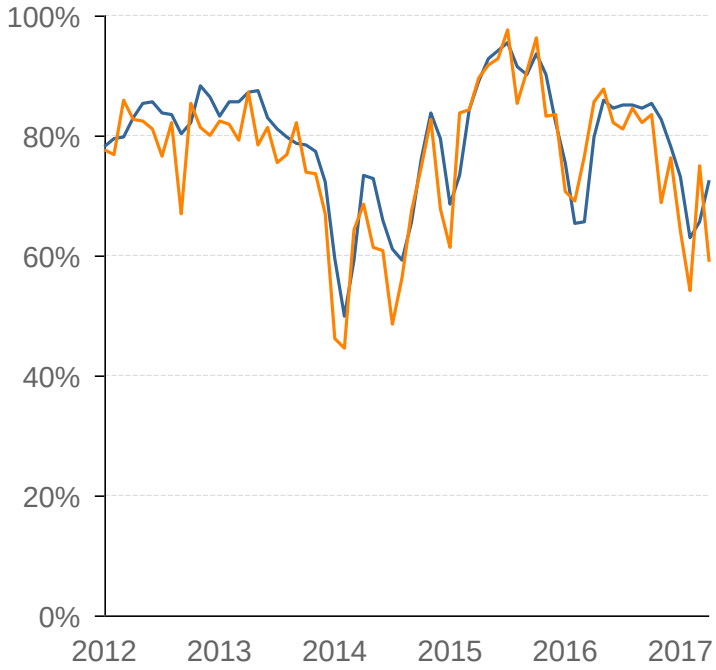


► Asia – North Europe trade developments, 2012 – April 2017

Indicative

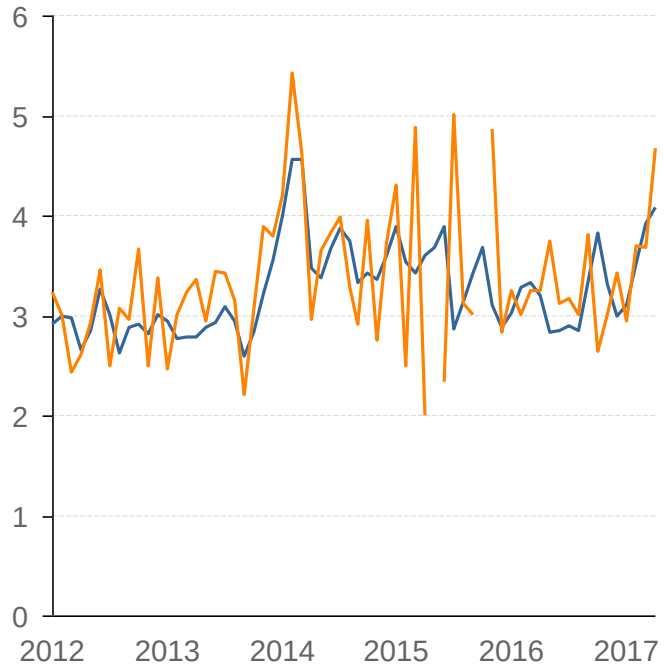
Asia – North Europe schedule reliability

%



Average delay for late vessel arrivals

days

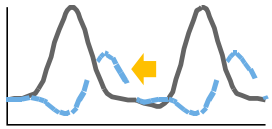


Source: SeaIntel; EY-Parthenon analysis

Root causes

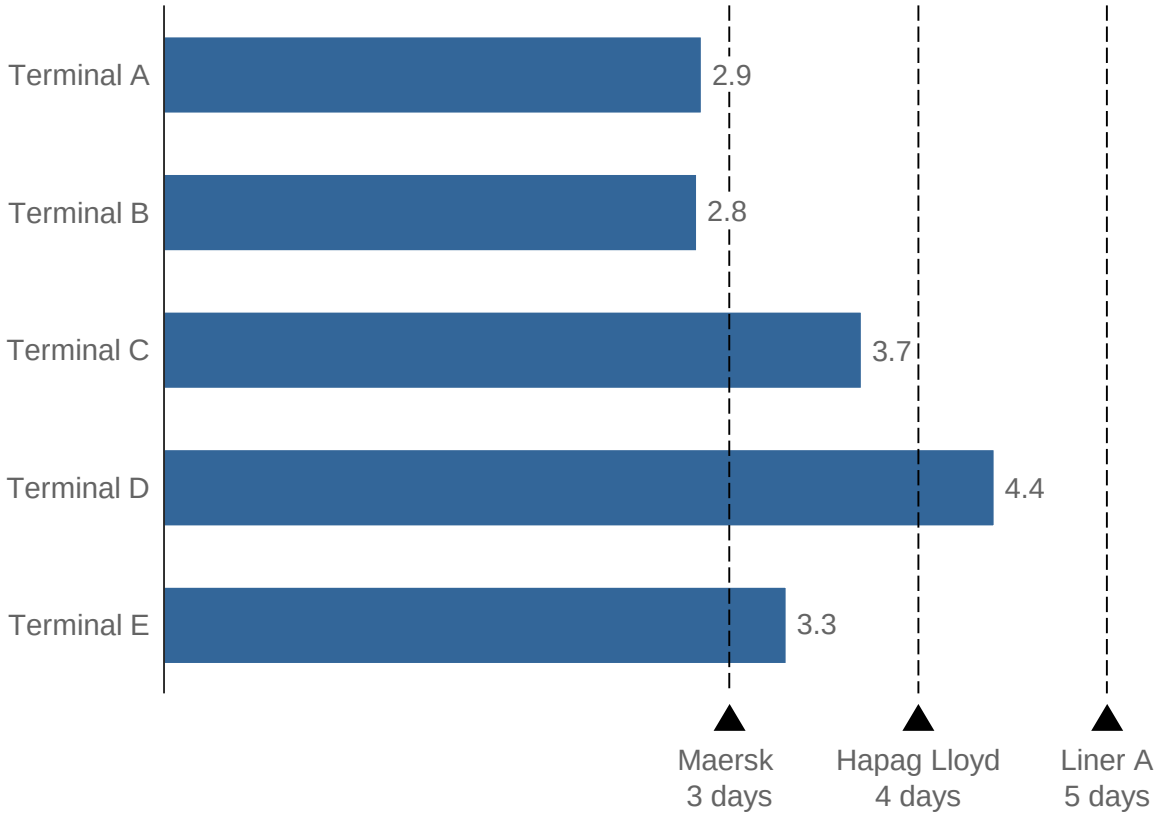
Multiple days are needed to move away the barge volumes after an import peak, sometimes longer than demurrage windows

2 Pick-up /drop-off windows



- **Barge handling time needed to handle average of 10 largest deep sea drops[1] per terminal**
- Days

Model calculation



Input for model calculation

Figure shows how many days it would take to manoeuver away the average of the 10 largest deep sea drops per terminal, based on:

- Realised modal split per terminal (1st half 2017)
- Average number of barges present per terminal (2017YTD)
- 2017 Realized moves per hour per terminal (1st half 2017) including mooring time
- 50/50 ratio loading and unloading
- 15% idle time per terminal to reflect amongst others no shows, planning inefficiencies and crane personnel breaks
- Excludes limitations due to barge operating schedules or other terminal visits

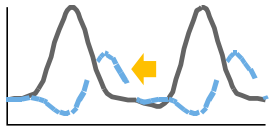
1. Defined by departure day in port

Source: Interviews; Port of Rotterdam; Company websites (Maersk / Hapag Lloyd); EY-Parthenon analysis

Root causes

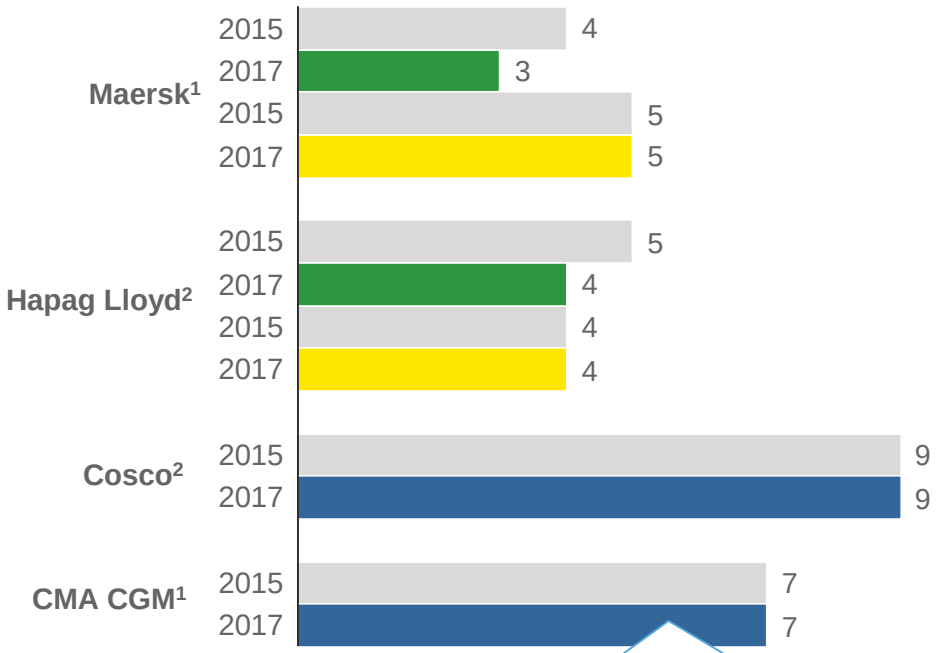
Peak demand for barge handling has increased as a result of tighter pick-up / drop-off windows and higher penalties

2 Pick-up /drop-off windows

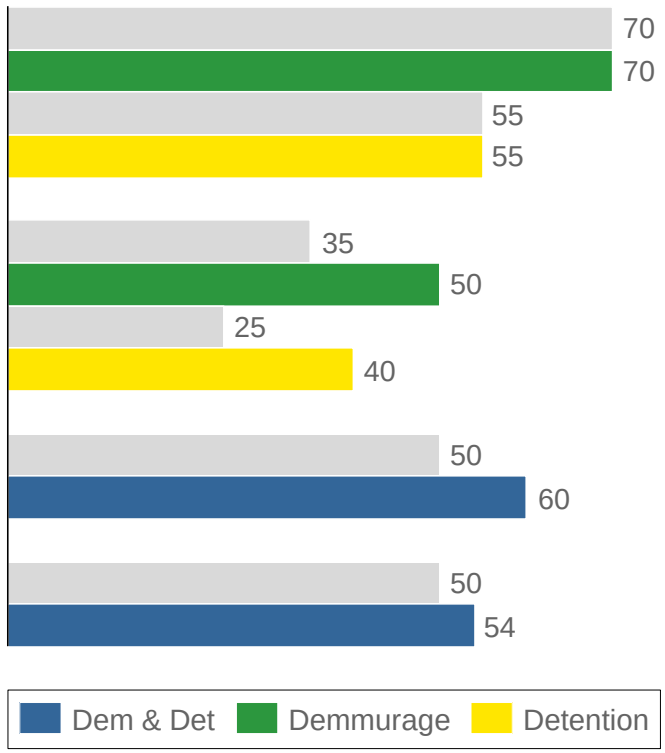


► **General demurrage/detention conditions for a 40'ft dry container, 2015 vs. 2017**

Maximum free and turnaround time
# of days



Demurrage and detention charges
€ per day



Practically, the free/turnaround time may be differ as:
- ► Demurrage/detention conditions may differ for larger shippers/forwarders, as they can agree on different buying terms
- ► It may be based on planned arrival/departure of a deep sea vessel, even during delays (mainly the case for export)
- ► Barges may be contracted with less free time if e.g. shipper or forwarder needs cargo earlier or wants to create a safety margin

No 2017 data available for MSC and Evergreen, though 2015 conditions are in line with other shipping lines

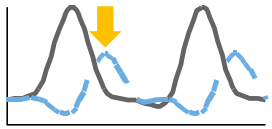
1. Day of discharge/gate out is included in free days
2. Day of discharge/gate out is excluded

Source: Company websites; Interviews; EY-Parthenon analysis

Root causes

Growing relative share of feeder activity, decreasing the quay and crane capacity available for barges

3 Feeder activity

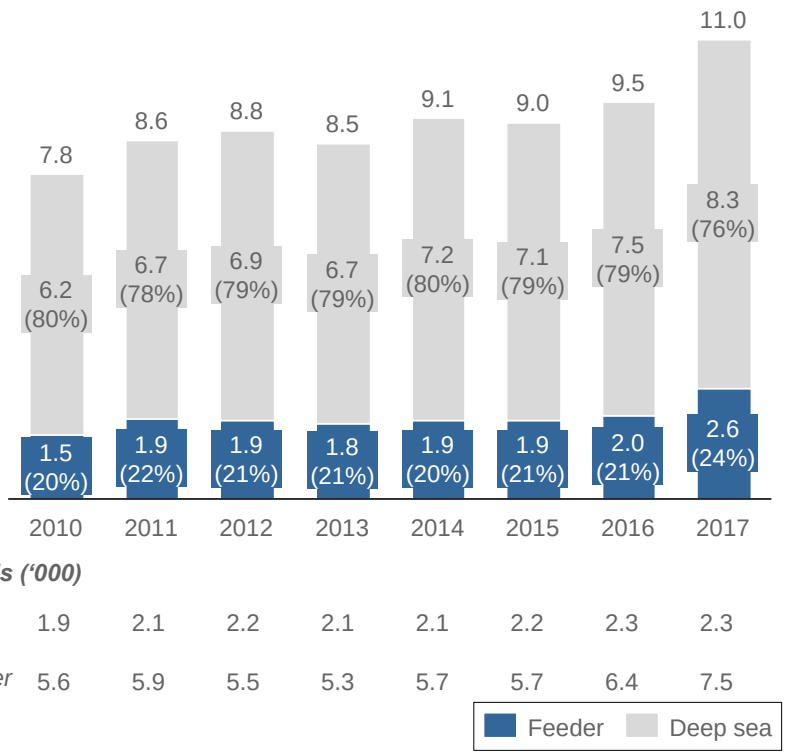


► **Barge handling capacity metrics**

Feeder volumes have grown in both absolute and relative terms

Volume handled at Maasvlakte, 2010 – 2017

m TEU

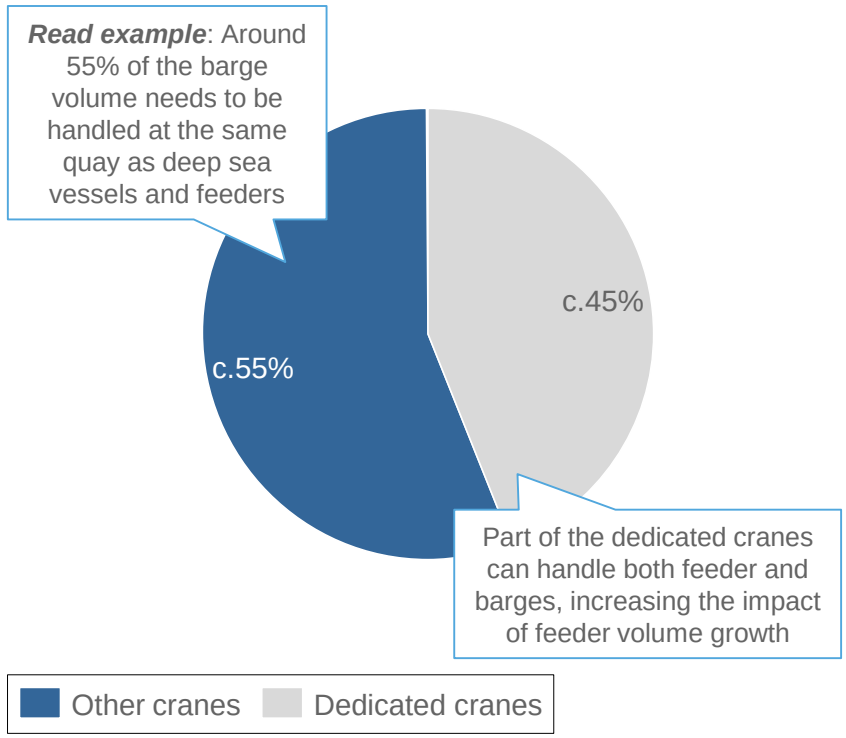


# Calls ('000)	2010	2011	2012	2013	2014	2015	2016	2017
DS	1.9	2.1	2.2	2.1	2.1	2.2	2.3	2.3
Feeder	5.6	5.9	5.5	5.3	5.7	5.7	6.4	7.5

More than 55% of the barge / feeder volumes handled at deep sea terminals competes with deep sea volume

Barge and feeder throughput handled by dedicated cranes[1], 2017H1 LTM[2]

% of TEU



1. 90% of total capacity based on number of dedicated feeder/barge cranes, an average moving speed of 20 containers/hour, 24h a day, 364 days a year. Assumed to be a theoretical maximum
2.H1 LTM = last twelve months; second half 2016 and first half 2017
Source: Port of Rotterdam; EY-Parthenon analysis

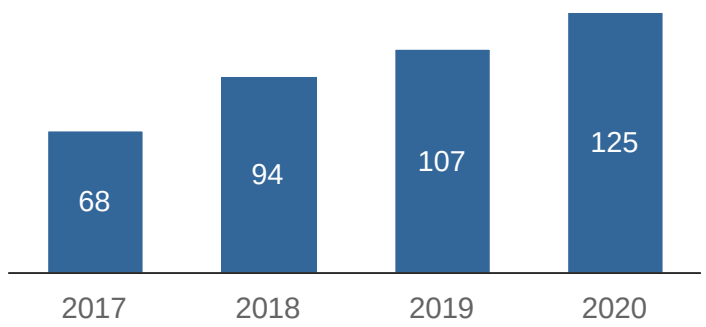
Root causes

Essentially, peak demand is a consequence of cost efficiency improvements at shipping lines

Reduction of cost due to scale benefits increases peak demand and limits barge capacity

- Large vessels have lower costs per TEU shipped
- In order to remain competitive all shipping line alliances are further expanding their ULCV (Ultra Large Container Vessel) fleet – *see graph below*
- Larger vessels drive both peak demand and limited capacity to move away these volumes:
  - Deep sea call sizes are increasing, especially for the largest calls
  - Larger vessels create a shift towards a hub-and-spoke model, which leads to higher quay occupancy by feeders

Estimated ULCV counts of the 3 alliances, 2017 – 2020
# of vessels

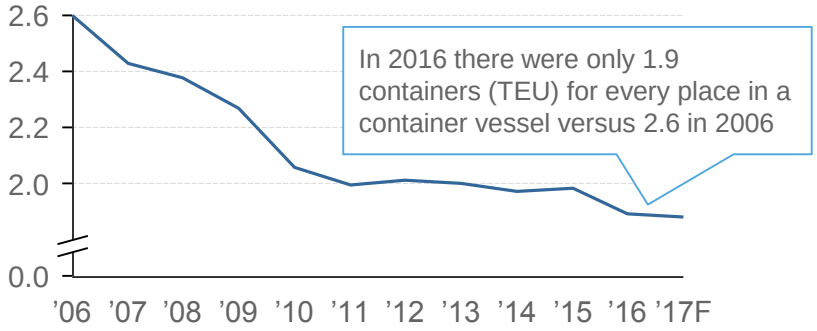


Reduction of vessel idle time and fuel consumption leads to delays

- High cost of capital of container vessels incentivises shipping lines to plan deep sea legs tightly
- In case of delays, however, a higher speed to compensate is unattractive as this leads to significantly higher fuel costs. This is not offset by the costs of capital that may prevented
- Tight planning combined with reluctance to compensate for delays leads to structural and significant delays

Reduction of capital employed on containers drives more stringent demurrage and detention conditions

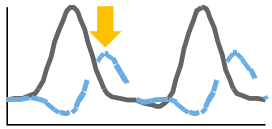
Total Container stock vs. total container fleet capacity, 2006 – 2017F
Ratio



Source: Drewry; Bimco; EY-Parthenon analysis

Root causes

Deployed barge handling capacity has decreased at some terminals, also corrected for volume developments



"As a result of increased competition on the Maasvlakte, by the opening of new terminals, some players have **reduced personnel deployment**"

- Barge operator

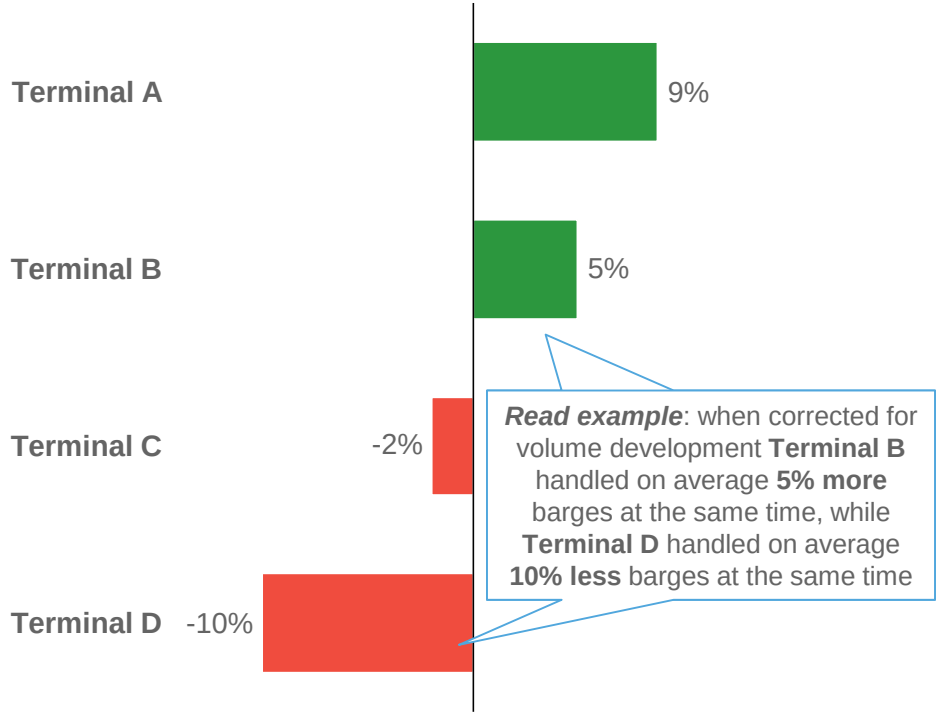
"Sometimes we cannot be handled at a terminal while we see that there are almost **no cranes in operation**"

- Barge owner

"Container volumes probably **outgrew what terminals were expecting**"

- Barge operator

Delta in avg. # of barges handled simultaneously, 2016 vs. 2017
% (volume corrected)



N.B. These developments changes over time, e.g. comparing the first half of 2016 and 2017 terminal B may well have handled less barges simultaneously than volume development would require

1. Excluding July and August in both years

Source: Port of Rotterdam; Interviews; EY-Parthenon analyses

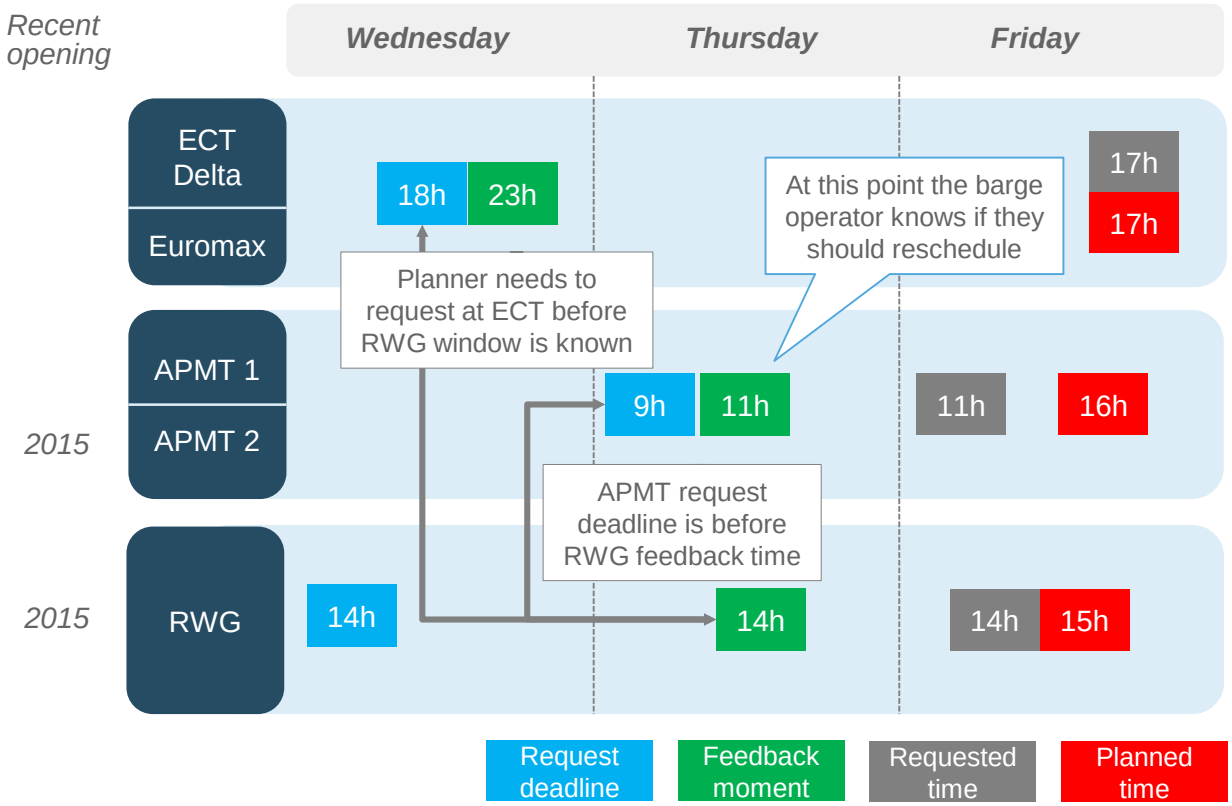
Root causes

Planning of barge handling at terminals is not aligned, driving congestion as it leads to inefficient barge routes and – as a result of now shows – inefficient use of capacity

► **Overview of planning procedures at different DS terminals and resulting unused planned capacity, 2017**

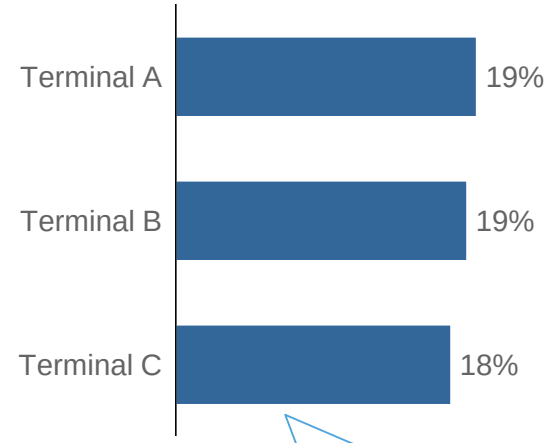
The planning made by the terminals may conflict with one another...

Example of the planning process for barge visits on a Friday at the Maasvlakte



...driving part of the to idle quay capacity

No shows[1] and cancelled moves
% of planned capacity



N.B. *Part of the cancelled moves may be driven by weekend closure at shipping lines. This leads to a safety margin in the planning for which administration needs to be ready 3-4 days upfront for a vessel leaving on Sunday, although cargo may not be ready yet*

1. Definitions differ by terminal. Terminals A,B and C do not match the terminal owners on the left-hand side of the page

Source: Terminal data; EY-Parthenon analysis

Root causes

Inland terminal development, increased number of deep sea terminals, overall volume growth and changing alliances have no or limited impact on congestion

	Description of the root cause	Rationale	Root cause	More info
Root cause with low impact	Shippers' focus on reduction of working capital leads to '**just in time**' delivery and smaller call sizes	► Despite hard figures on the relevance of '**just in time**' there is consensus that it only impacts part of the container flow ► Call size has limited impact on congestion (*see next page*)	**10**	***p.76***
Falsified root cause	Increased **number of barge operators / inland terminals** leading to small call sizes	► Dutch hinterland volume growth offset the increase in number of terminals driving call size up ► Consolidation and collaboration drove call size up for the Rhine and Rotterdam – Antwerp	**7**	***p.60***
	Overall **increased volumes** leading to higher average utilisation of the quays	► Since 2014, volume growth of 11% was more than offset by the increase in sea side cranes (34%) due to new terminals opening	**11**	***p.80***
	Opening times of hinterland and depots (not opened in weekends and at night) further increasing peak demand for barge quay capacity at deep sea terminals	► Opening times of inland terminals projected on Rotterdam smoothen out due to the difference in transit time ► Empty depot opening hours do seem a limiting factor, though it does not seem to increase peak demand	**6**	***p.56***
	Changes in shipping line alliances, leading to **(temporary) inefficient deep sea vessel schedules**	► Delays of deep sea vessel has been increasing since 2015, far before the changes in alliances	**13**	***p.84***

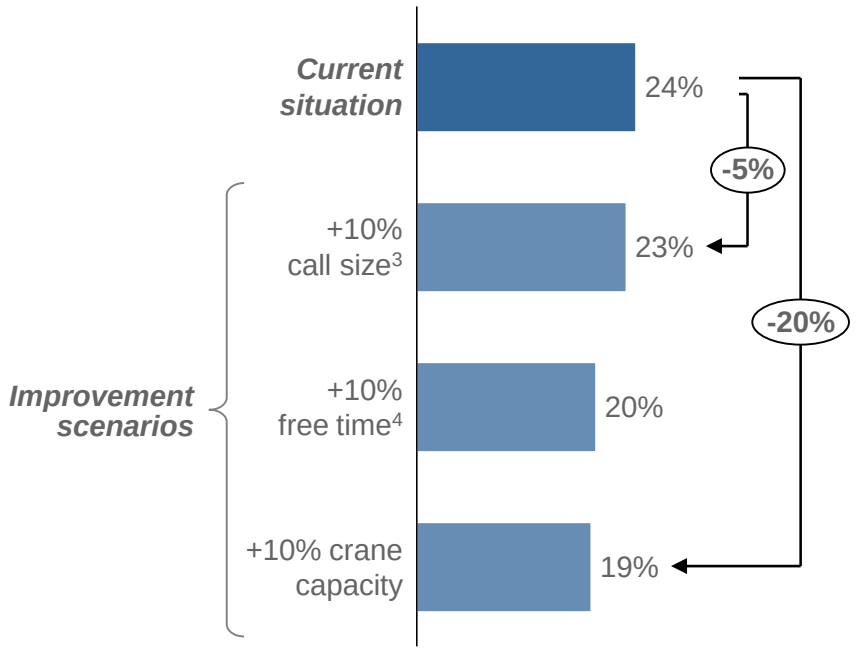
Root causes

Hypotheses relating to call size have limited impact, as other development such as number of cranes or free time have significantly more impact on congestion chances

The impact of call size on congestion at deep sea terminals is relatively small compared to other drivers

- Chance of all cranes being occupied – 2017
- %

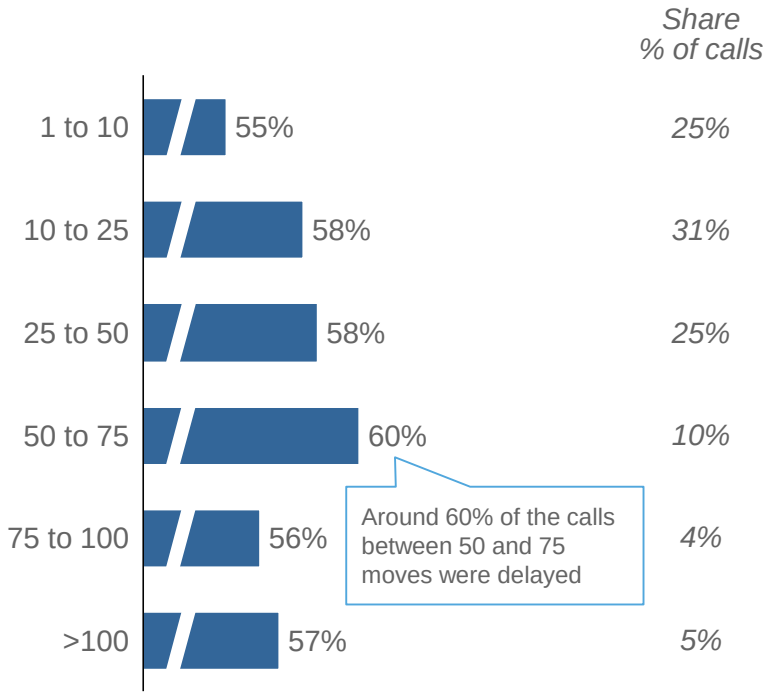
Model calculation[1]



For more details, please refer to p.35-39

Furthermore, there does not seem to be a benefit in handling reliability for larger call sizes

- Share of barges delayed[2] by call size – 2017
- % of calls



"We prefer larger call sizes as they are easier to plan, **however small calls** are more often handled **on time**"

- Barge planner

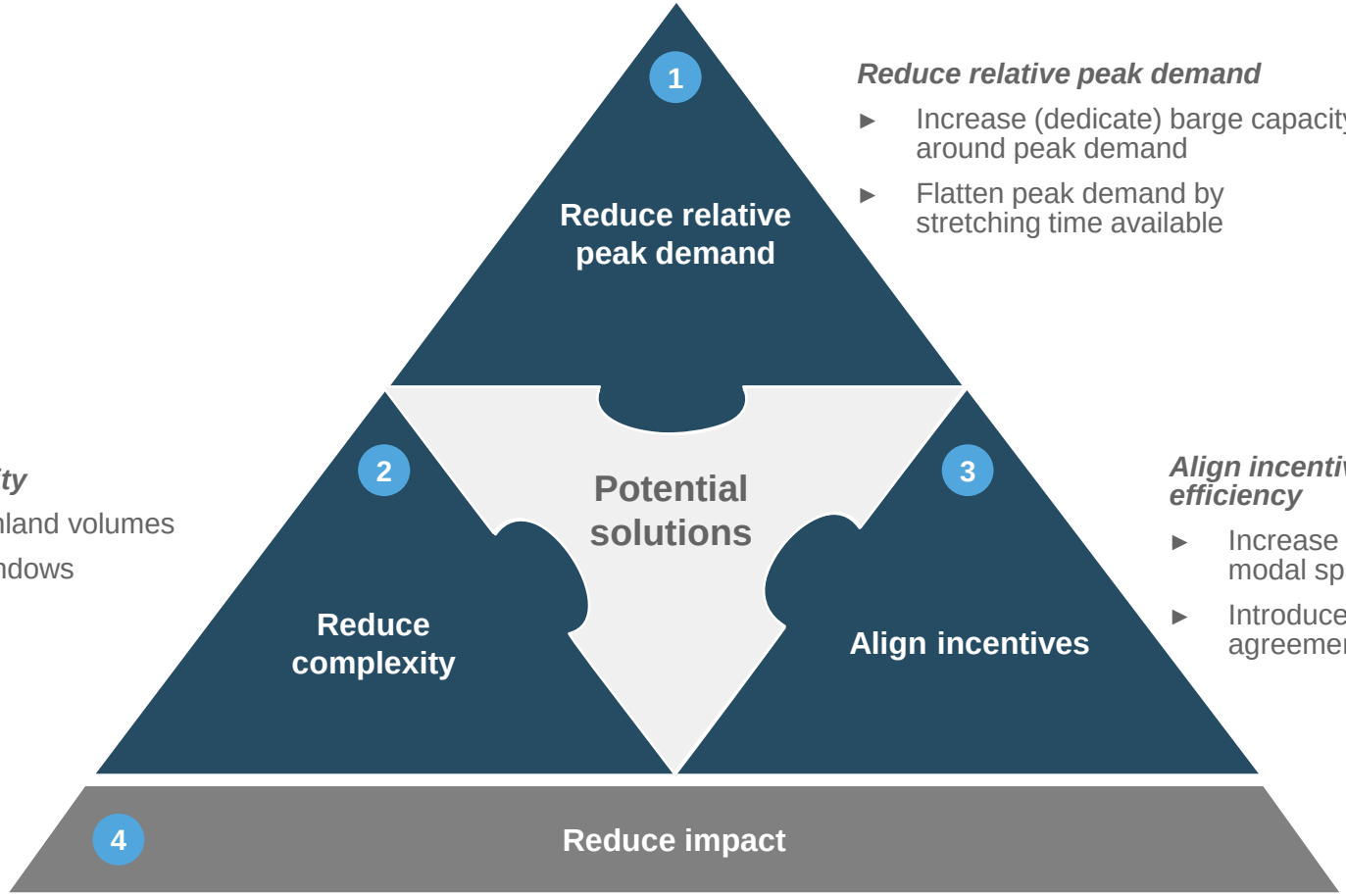
1. Based on queueing theory
2. Delayed is defined as start of operations 30 minutes or later than planned
3. Including crane efficiency improvement associated with larger call sizes
4. Excluding effects from possible overflow of stack which may decrease handling speed

Source: Portbase, Terminal data; Port of Rotterdam; EY-Parthenon analysis

Agenda

Potential solutions

Potential solutions for congestion lie along three main axes; Workgroup 1 will continue to develop specific solutions



Reduce relative peak demand

- Increase (dedicate) barge capacity around peak demand
- Flatten peak demand by stretching time available

Reduce complexity

- Consolidate inland volumes
- More fixed windows

Align incentives to increase chain efficiency

- Increase incentives to improve modal split
- Introduce service level agreements

Reduce impact of root causes

- Increase opportunity to deal with disruption (time / info available)

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