Handling of Inland Vessels in Seaports – Necessary Actions and Additional Options to Support Container Transport on Inland Waterways

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Abstract. Deep sea container transport is despite the existence of various crisis situations a worldwide steady growing business and as a result seaports need to handle ever growing container volumes. Transporting these containers with as little as possible emissions, efficiently and in a reliable manner from the seaport into the hinterland has strategic importance for the attractiveness and hence the competitiveness and growth potential of a container seaport. For ports having access to the hinterland by inland waterways, inland shipping is a mode to contribute to hinterland accessibility and to provide a more environmental-friendly and safer solutions for hinterland transport compared to truck transport, which is still very dominant.

The physical as well as the informational interfaces between the seaport and the hinterland modalities (truck, train and inland vessel) appear to have significant importance for the overall cost and quality performance of the hinterland transport chain, in particular on relatively short transport distance. Several container seaports world-wide have a well-developed hinterland transport system for container barges, but are facing inefficient handling processes of inland vessels in the seaport which cause tempered growth of container inland shipping.

This paper discusses different causes for inefficient handling of container inland vessels in seaports and evaluates initiatives, proposals and necessary actions for improvement. These matters are discussed in the context of the major Northwest-European container seaports. Solutions can be found both in organisational, information-based and technical improvements. These improvements are jointly needed to realise the growth ambitions for container inland shipping.

Keywords: Container transport · Seaports · Inland shipping

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1 Introduction

The quality of hinterland transport has become increasingly important for the competitiveness of a seaport. Shippers and carriers value the attractiveness of a port not only on the performance of the seaport, but also on its hinterland accessibility and thus consider a ports competitive position not any more as a single important argument but include the overall port activities into a combined supply chain performance approach. In fact, large seaports are important transshipment places, not only for maritime vessels, but also for inland vessels, as they represent the interface between maritime trade and hinterland transport. This hold for the container transport market in particular. Containerisation has changed liner shipping spectacularly and affected seaports and their hinterland transport systems. Ports are much more in competition to serve the same hinterland areas. Especially in Northwest-Europe, where the distance of container ports to major hinterland areas is not very different. This has made hinterland accessibility a strategic matter for the competitiveness of seaports.

In the largest container seaports in Europe, inland container shipping has developed as a major mode for hinterland transport. In Rotterdam 3 million TEU were transported by barge in 2020 with a market share of 32% in hinterland transport. Antwerp recorded 2,5 million TEU with a market share of 35%. The German ports of Hamburg and Bremerhaven recorded significantly lower shares between 2% and 3%, as their focus is due to their geographical position and traditional development put on rail transport. In view of increasing global container traffic, accessibility and achieving their sustainability goals, most seaports are targeting larger volumes to be handled by barge and aim at increasing its modal share (e.g. Rotterdam targets a market share of 45% at Maasvlakte area in 2033). This is also driven by the ambitious national and European modal shift to inland waterways targets with dedicated organisations and specific strategic targets in almost all European countries. Over the last 15 years, however, while the modal split share of barge in the main seaports of Rotterdam, Antwerp and Hamburg has increased slightly (Table 1), efforts are still needed to achieve their modal split targets.

Table 1. Development of modal split in container hinterland traffic in port of Rotterdam, Antwerp and Hamburg, 2005–2020 (x 1.000 TEU and %)

	Rotterdam		Antwerp		Hamburg	
	2005	2020	2005	2020	2005	2020
Truck	4.056	5.296	3.897	4.214	2.991	2.490
Barge	2.056	3.026	2.312	2.491	102	128
Rail	634	978	540	484	1.420	2.808
Total	6.746	9.300	6.749	7.189	4.513	5.426
Truck	60%	57%	58%	58%	66%	46%
Barge	31%	33%	34%	35%	2%	2%
Rail	9%	10%	8%	7%	32%	52%
Total	100%	100%	100%	100%	100%	100%

Source: port authorities.

Studies (e.g. Shobayo and Van Hassel, 2019) show that the handling of barges in the seaport has a great impact on the performance and reliability of barge services to the hinterland (dependent on transport distance easily 30% of the total hinterland chain costs) and that the current handling processes in the seaport suffer from different problems. Improvement of the handling operations in the seaports is therefore an important avenue to increase competitiveness and support growth of container inland shipping. In fact, in order to exploit the potential of container transport even further, a constant improvement of inland navigation's integration into logistics chains is a cornerstone, in particular to adapt to changes affecting global trade flows. In addition, recent events such as the Covid-19 crisis, the Suez Canal incident (ship blockage) as well as the Brexit, led to increased congestion issues at the level of seaports, highlighting further their vulnerability and the need to find solutions to address this challenge. In the next section the details of the inefficient handling process are unravelled. Next different possible solutions to improve the process are discussed. The paper ends with conclusions and future perspectives.

2 Current Processes and Problems with Handling Container Barges in Seaports

Inefficient handling of container barges in seaports is not a new problem and seem to remain a persistent problem due to multiple mutually related factors:

- Barges very often have to call many (easily 6 to 9) deep-sea terminals in the seaport: this is time consuming and leads to many small call sizes that also lowers the overall terminal productivity.
- Many barges call at the same terminal: it causes congestion and waiting times.
- Sea vessels in general have priority over barges since there is no contractual relation between terminal operators and barge operators: this causes additional congestion and waiting times, especially when the handling equipment for deep-sea vessels is used to handle barges.
- The technology used for the handling of deep-sea vessels becomes in combination with the continuous rise in ship sizes less competitive if this technology is also used for barge handling.
- A delay at one terminal can easily lead to missing agreed time windows for handling at the following terminals, i.e. causing a domino-effect. For instance, in Rotterdam in 2019 and in Antwerp in 2020, delays amounted up to 20–30 h on average, but peaks of 60 h were sometimes registered.
- Lack of coordination in the planning of handling barges since the planning takes place bilaterally between the terminal operator and barge operator: both actors may be responsible for disturbing the planning.

  The implication of these process characteristics is that barge services become more expensive (because the turnaround time of barges in the seaport is too long, that is to say making the barges less productive), less reliable (because of the unpredictable delays) and may increase the transit time of individual containers. Ultimately, this can lead to loss of competitiveness for barge compared to other modes.

  The negative impacts on the barge service performance are further enhanced by the following circumstances and developments (CCNR, 2022):

- Growth in container traffic in general causing more pressure on the handling capacity of seaports, although ports may have expansion plans.
- Increasing scale of deep-sea vessel and call size that create greater peaks in demand for handling capacity, and consequently may lead to longer waiting times for barges. The capacity of the largest deep-sea vessels calling at the north western European Ports exceeds 24.000 TEU. The average call size on such vessel i.e. has continuously increased to 8.300 TEU in Rotterdam.
- Lack of dedicated handling capacity for barges at the individual seaport terminals. Moreover, using expensive cranes to handle deep-sea vessels also to handle barges makes the handling of barges not only unnecessary more expensive, but also slower.
- Unreliable deep-sea container shipping schedules that make the planning of handling barges less reliable.
- The strong commercial position of maritime actors compared to inland operators, strengthened further by a wave of market consolidation also took place in the last decades in the global container shipping industry, creating further imbalances in the global container trade.
- Increasing tightening of demurrage and detention conditions by shipping companies which puts more pressure on the timeframe in which containers can be supplied or disposed of free of charge around a deep-sea call and further increases the peak load.

To conclude, to overcome the inefficiencies of the current handling process of barges in the seaport solutions should contribute to a more reliable and faster process.

3 Measures and Best Practices to Improve the Handling of Container Barges in Seaports

As shown, the inefficiencies in barge handling have different dimensions: organisational, technological and information-based. This observation is directional for promising solutions. However, politics and regulation can also play a role.

3.1 Organisational Developments

The most common pattern of container barge services consists of one or a very few terminal visits in the hinterland and a rather large number of terminal visits in the seaport. The need to visit many seaport terminals arises from the fact that a shipment of containers of one inland terminal consists of shipments of several deep-sea lines calling at different seaport terminals. Together these shipments can fill a barge. A different way of bundling container flows can lead to a reduction in the number of terminal visits in seaports and an increase in call size. Both results are beneficial for the barge operator and deep-sea terminal operator. Alternative bundling of flows can take place in the seaport and in the hinterland.

Hub Bundling in the Seaport

Hub bundling is a very effective approach to realise benefits from network operations (economies of scale, density and scope). The decoupling of barge services on the seaport side and hinterland side enables several advantages:

Performance improvement of barge hinterland operations:
- Improvement of the hinterland vessel turnaround time (higher productivity);
- Improvement of the costs and reliability performance of barge hinterland services.

More efficient performance of deep-sea terminals:
- A higher crane/quay productivity, because the average productivity of handling containers in large call sizes is higher;
- A better utilisation of space at deep-sea terminals as the dwell time of containers at deep-sea terminals can be reduced if the hub terminal can also facilitate a storage function for (empty) containers.

Moreover, port accessibility can be improved if the hub terminal can act as an 'extended gate' for container trucks that drop and pick up their containers at the hub instead visiting the deep-sea terminals. In this way the congestion on roads in the port region will be reduced.

The economic advantages of hub bundling, however, should be large enough to compensate a main disadvantage, i.e. the costs of the extra transhipment operation in the hub.

In the port of Antwerp, the concept of bundling was first introduced through the implementation of a five-year project in 2018 that was submitted to the European Commission. The successful results of this test led to the full application of the bundling concept in the port and since the beginning of January 2021, barge operators WeBarge and Contargo Transbox have been operating container shuttle operations together in the port of Antwerp. They are now bundling their volumes at consolidation hubs which organise the transport to and from the maritime terminals at a fixed transport rate per hub.

Since 2018, the Port of Rotterdam also implemented this concept of container bundling. In the port, containers are bundled at Maasvlakte, Waal-Eemhaven and Alblasserdam and transported directly by inland vessels to and from the deep-sea terminals according to a fixed schedule.

These initiatives in both ports have resulted notably in call sizes that are two to four times bigger than previously and in shorter port calls (approximately - 40%).

Hub bundling is so far mainly noticeable in these seaport regions, but could also be applied at greater distance from the seaport. The inland port of Duisburg (at 250 km distance from Rotterdam) can also perform the hub function very well (Fig. 1).

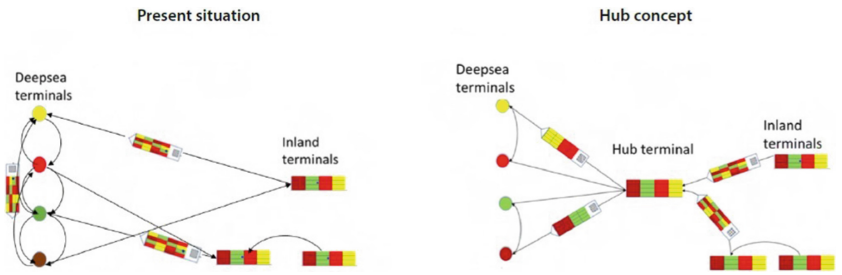

Fig. 1. The hub bundling concept (source: CE Delft, 2020)

Corridor Bundling in the Hinterland

Bundling taking place in the hinterland with services to the port of Rotterdam are organized in the form of corridor partnerships, that is to say, it is based according the bundling principle of line bundling along a corridor.

Various barge operators and inland terminals located along a hinterland route have decided to work together to bundle the flow of containers destined for specific deep-sea terminals. As a result, large volumes of containers can be moved between the different deep-sea and inland terminals using inland vessels that sail according to a fixed schedule. In addition, the barge operators and the deep-sea terminals have agreed to load and unload containers during specific time slots, and to put through a minimum number of containers (moves) per inland vessel. These agreements have made the handling of inland container shipping flows in the port of Rotterdam both more reliable and more efficient.

The first corridor partnerships set up in 2018 were the West Brabant Corridor (WBC) and the Ruhr Express and they have been successful. Some results from the WBC: the call size tripled, 30% shorter duration times of vessels in the seaport, 30% reduction in number of barge visits at deep-sea terminals, 75% fewer deviations in visit appointments and a modal shift from truck to barge of 20%. Soon the North West central corridor and the Limburg Express were also established.

In Belgium, the government is going to launch a subsidy program to support the development of corridor bundling (Logistiek Magazine, 2022) (Fig. 2).

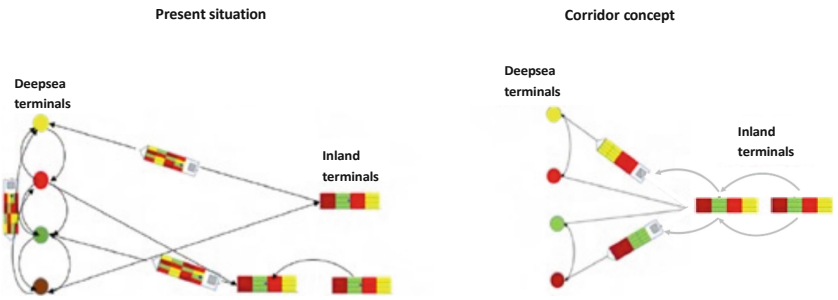

Fig. 2. The corridor bundling concept (source: adapted from CE Delft, 2020)

Push Barge 'LEgo' System

This proposed concept, having similarities with the hub bundling concept but without applications so far, is aimed at optimisation of the utilisation rate of the deep-sea terminal quays, by decoupling the loading and unloading process at the terminal. The system is based on the use of unmanned push barges that are buffered in the port area and called for (un-)loading whenever capacity is available (Fig. 3).

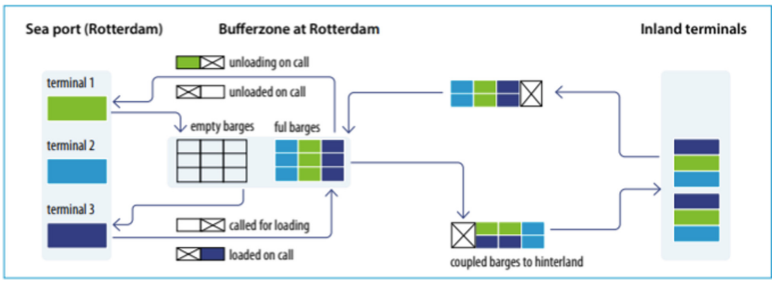

Fig. 3. The push barge 'Lego' system (source: CE Delft, 2020)

3.2 Cooperation and Exchange of Information

In the current planning process of handling barges, planners make a plan for their own vessels and quays and hence only know their own plan and available capacity. Therefore, it is often impossible to achieve a match between demand and supply. However, for the short-term, it is clear that cooperation and exchange of information between the different actors in the transport chains and port operations can generate "quick-wins". Many examples can be found in main seaports regarding how to improve information sharing. However, a key challenge is to make information systems compatible with each other so that they can be used by all those involved in the process. A prerequisite for this is also the willingness of all process participants to share their information with each other.

At the port of Rotterdam, Nextlogic is a tool and information platform that offers an integral, port-wide and neutral planning of the handling of container barges in the port of Rotterdam. The planning is feasible and appropriate for all parties based on the delivered information, pre-defined KPIs and calculation rules. The system continuously optimises taking into account real-time changes. Sharing correct and complete information in time by all relevant actors is a key requirement for the well-functioning of the planning system.

Following a pilot five barge operators and three terminals were using Nextlogic at the end of 2021. More participants are envisaged and also required to make the system functioning truly well (Fig. 4).

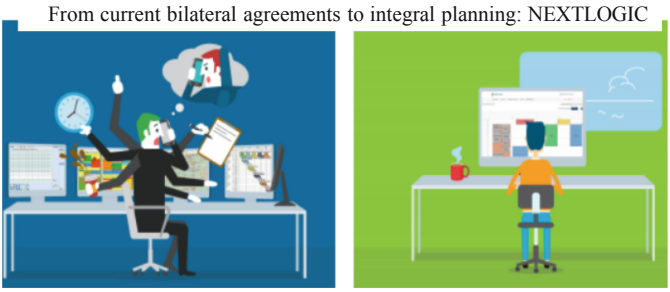

Fig. 4. The NEXTLOGIC planning system (source: Nextlogic)

A similar system also exists in the Port of Antwerp, where the platforms "C-POINT" and NextPort offer a complete package of applications to promote digital communication between all actors present in and around the port.

3.3 Technology: Dedicated Infrastructure and Innovative Transport and Transhipment Technologies

Investments in dedicated barge handling infrastructure in the seaports is without doubt an effective solution. Small cranes could be used to save handling costs of the barges and dedicated handling space for inland barges can reduce the waiting time of the barges. Nevertheless, outstanding issues remain, notably as to which actor would bear the responsibility of these investments and what the cost-benefit analysis of these investments would be.

Except for just creating more handling capacity it remains interesting to consider new vessel, terminal and transhipment technologies that enable a cost-efficient and fast (un-)loading process of vessels, benefitting from the possibilities of further increasing the scale of vessels and automation and robotisation.

Over the last three decades, and mainly in the nineties of last century, a lot of concepts with a technological component were launched and developed (see Binsbergen et al, 2009). Although studies showed their technical feasibility it appeared difficult to bring these concepts to market realisation.

Inspired by the terminal automation of ECT in Rotterdam the Barge Express-concept (1996) contained deployment of very large push-barge units (624 and 2x280 TEU capacity) to reduce sailing costs and automated loading/unloading to reduce handling costs. Quay transport could be performed by the also well-known AGVs. Except for the automated crane the concept was based on proven technology and hence the investment costs and risks were rather limited. Although technically feasible it was economically not, because the transport volumes were insufficiently large at that time. It would be worthwhile to reconsider this and other technologically advanced concepts again in the current spirit of the age (Fig. 5).

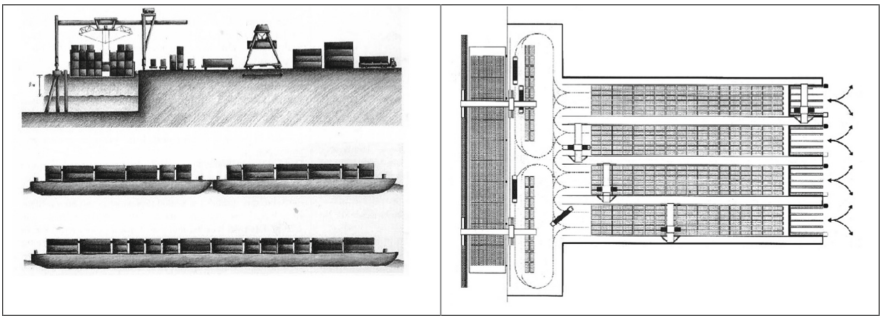

Fig. 5. Barge Express: perspective for large-scale container barging (source: TRAIL Onderzoekschool, 1996)

4 Conclusions and Perspectives

In view of increasing global container traffic, port-hinterland accessibility and sustainability goals main container seaports in Western Europe are targeting larger volumes to be handled by inland shipping. Although the volumes transported by barge have generally significantly increased during the last two decades it has remained a big challenge to increase the market share of barge transport in hinterland container traffic. Hinterland container barge transport is suffering from inefficiencies in the handling of inland vessels in the seaport. Considering the great impact of this handling process in the overall performance of barge services to the hinterland solving the inefficiencies in container barge handling in the seaport is an important avenue to improve the attractiveness and create growth potential for barge transport in hinterland container traffic.

After a long struggle in solving this problem, some concrete promising initiatives have now been implemented or are envisaged. Important actions that have been undertaken to improve the handling of barges are the reorganisation of barge hinterland services and the improvement of the information process regarding the handling of barges in the seaport. The first experiences seem positive. Although these actions tackle important dimensions of the inefficiency problem more actions are needed. Historically, barge has never been a standalone transport mode as it has always had to use the infrastructure of deep-sea vessels. In view of the huge ambitions in terms of the modal share of barge transport the role of the inland shipping mode at deep-sea terminals should be revalued. This revalue requires more than the current organisational and information-based improvements: for instance (more) own facilities (quays and cranes), but also use of innovative technologies (automation and robotisation), that are already being rolled out to handle deep-sea vessels, need also become available to handle barges.

Overall, inland container handling inefficiencies in seaports are considered to be strongly linked to commercial issues which might not necessarily be solved by additional regulatory measures. Nevertheless, national public authorities can have a non-negligible capacity to influence this issue. Indeed, the fact that the problem of handling inefficiencies in seaports is a long lasting issue, seem to demonstrate that such inefficiencies cannot be solved by the market alone. This would ultimately lead to difficulties in achieving the ambitious European and national modal shift to inland waterways targets. This justifies possible interventions on the side of national public authorities.

References

Binsbergen AJ van, MGM van der Horst, A Veenstra and R Konings (2009) containerlogistiek in de binnenvaart, delft: trail onderzoeksschool

CE Delft (2020) outlook hinterland and continental freight 2020, delft

CCNR (2022) assurer un chargement/déchargement plus rapide et efficace des conteneurs en navigation intérieure dans les ports maritimes - analyse du Secrétariat, Strasbourg (forthcoming)

Logistiek Magazine (2022) Vlaamse regering: 'modal shift naar binnenvaart stimuleren' [Flemish government: encouraging modal shift to inland shipping] https://www.logistiek.nl/182630/vlaamse-regering-modal-shift-naar-binnenvaart-stimuleren

Shobayo P, E van Hassel (2019). container barge congestion and handling in large seaports: a theoretical agent-based modelling approach. J Shipping Trade 4 26

TRAIL onderzoekschool, business development international, Arthur D. little international, vuyk engineering rotterdam (1996) barge express: perspectief voor grootschalige binnenvaart, Delft