www.icplt.org
March 17th — 18th, 2021 | Darmstadt, Germany
Interdisciplinary Conference on Production, Logistics and Traffic

Enhancing container barge transport in Europe

Peter Shobayo[1] Edwin van Hassel[2] Thierry Vanelslander[3] Bilge Atasoy[4]

[1] University of Antwerp, Department of Transport and Regional Economics, Antwerp, Belgium.
[2] University of Antwerp, Department of Transport and Regional Economics, Antwerp, Belgium.
[3] University of Antwerp, Department of Transport and Regional Economics, Antwerp, Belgium.
[4] Delft University of Technology, Department of Transport Engineering and Technology, Delft, The Netherlands.

Abstract. This paper analyzed the market developments and identified the current situation and challenges of container barge transport in deepsea and inland terminals. It was revealed that the major challenges of container IWT include; inefficient handling of barges, poor planning and coordination, lack of flexibility in container barge transport and low water levels. To solve these challenges, innovative solutions such as mobile terminals, vessel trains, cargo reconstruction, and smart navigation are proposed. The impact of these innovations is currently being examined by using the discrete event simulation (DES) model.

1 Introduction

An increase in the share of intermodal transportation has given the hinterland transportation a dynamic interface, as it has helped in enhancing port accessibility through the reduction of cargo from the congested roads and focusing on the transportation of these cargos by either the waterways or the railways. Inland waterways have so far contributed to the development and performance of port activities in North-West Europe. There has been a great emergence of container transportation through inland navigation over the years. This is because this type of transportation brings about efficient accessibility to different regions which are close to the river area such as the river Rhine and the Maas as seen in Figure 1.

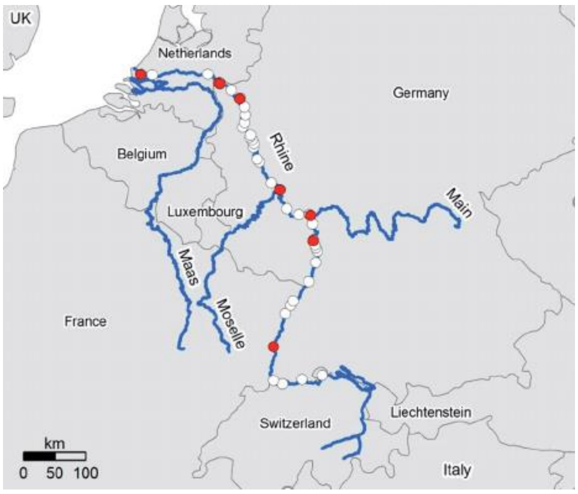

Figure 1: Important European IWT network (Rhine and Maas). Source: (Loos & Jones, 2011)

This mode of transportation offers a clean and cost-efficient method of accessing the hinterland, economies of scale and density generation as compared to transportation via trucks, and have thus far enhanced the competitiveness of ports by attracting several shippers and carriers to the port. (Shobayo & van Hassel, 2019).

Container barge transportation has today become an important mode of transportation in large seaports with IWT hinterland connection for three main reasons. Firstly, it serves as an efficient mode of transport as compared with other modes. Secondly, it helps to reduce congestion in inland infrastructure and other environmental impact associated with hinterland transportation. Finally, it creates a network of inland terminals which offer shippers an alternative for road transport to and from the deepsea ports, thereby leading to reduced freight transport cost, and reliable last-mile transport of large volume of goods between the inland terminal and the distribution centre.

2 Market development of container barging in Europe

A limited number of countries and ports in Europe have major connectivity to the IWT network. A significant share of I container transport performance on European inland waterways takes place in only four countries: the Netherlands, Belgium, Germany and France. The majority of the IWW container transport has origin and destination to these countries. Their quarterly performance in TEU was always above 400.000 TEU as revealed in Figure 2. The figure further revealed a decrease in container transport in 2018 in most Rhine countries. This is mainly due to low water levels on the Rhine in the second half of the year. From the figure, Germany had the strongest decrease (-9% in TEU) since the Rhine in Germany was much more affected by low waters than the Rhine delta in the Netherlands. In the Netherlands, the decrease was not so visible (-3% in TEU). France also witnessed a decrease (-5 %), which was entirely due to the French part of the Rhine, as container transport in other French basins was either stagnant or increasing. Belgium was the only country with a positive rate of change in 2018 (+3 %), as its container traffic is only partly Rhine-related.

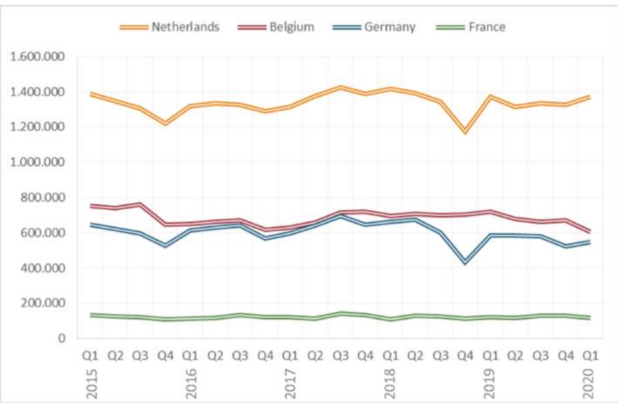

Figure 2: Quarterly container transport performance in top 4 IWW countries (in TEU). Source: (Novimove D.2.1)

The overall trend between 2007 and 2020 however revealed the increasing use of IWT for container transport. The reason for this increasing use according to Sys, Van de Voorde, Vanelslander, & van Hassel, (2020) can be attributed to the growth of container transport especially in the ports of Antwerp and Rotterdam in this period. Irrespective of this increased use in IWT, road transport still has a significant share in the transport mode of container freight transport as seen in Figure 3. The figure reveals the modal share of container freight transport in Europe between 2015 and 2018. As seen, road transport has a dominant share among the mode with an average of 76% over the identified years. IWT meanwhile has an average of 18% in the modal share of the EU countries. The significant share of road transport and the corresponding societal challenges associated with this mode of transport mode serve as a motivation for European countries with access to IWT network to shift cargoes from the road to IWT.

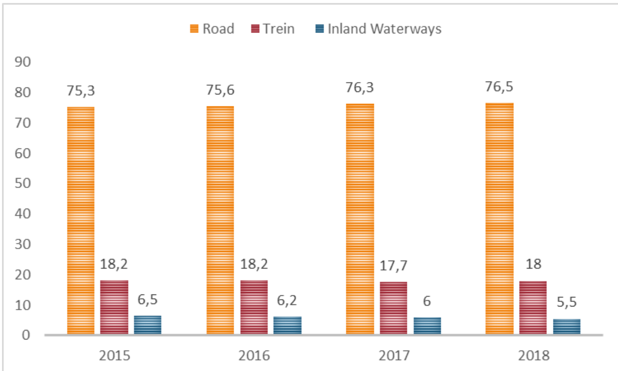

Figure 3: Percentage of European modal split of freight transport. Source: (Novimove D.2.1)

3 Challenges of container barging in Europe

Despite the significant importance of the inland waterways to large seaports with hinterland connectivity, barge transportation is still faced with several challenges which have negatively impacted the reliability of barge operations. These challenges begin with the arrangements between the shipper and the shipping agents, and further extend to the operations, handling and navigability and capacity utilization of inland container barges. The various challenges are elaborated below.

The first challenge of container barge transport starts with the appointment between shippers and shipping agents about the arrangements of transport conditions and delivery options to and from the port. Generally, barge transportation is cheaper than trucks (services offered by inland terminals), enticing shippers with a large volume of containers to make use of the transport service. This has led not only to the growth of container transport but also to high expectations that are similar to that of road transport (fast, reliable and timely). Unfortunately, container barges have been unable to meet these expectations partly due to the level of coordination and agreement that is needed from various parties in the transport chain.

Secondly, inland barges have small call sizes (<20 TEUs) and have no contractual relationship with deep-sea terminals. Due to the small call sizes, they have to make several calls to the different terminals (6-8 calls) but because they have no contractual relationship with the deep-sea terminals, they need to wait for available wharf and crane facilities at each terminal, thereby disrupting their planning and leading to high congestion level in the port. It has been estimated thatthe waiting time and sailing time between the different terminals contributed to at least 60% of the total time spent in the port.

Thirdly, container barges mostly operate with an average low load factor[a]of about 55%. This means that container barges are often not loaded to full capacities, leading to sub-optimal use of the IWT capacity, and terminal infrastructures. Due to the low load factors, deep-sea terminals have little incentive to allocate terminal resources to handle these vessels, as it often leads to low productivity and inefficient utilization of terminal resources, which are mainly designed to handle the deep-sea vessels.

More so, the varying water levels along the Rhine[b] have had a negative significant impact on the occupation rate of container barges thereby influencing transport price. Concerning the transport price of freight IWT, it is observed that the transport price of freight within the IWT are unstable and sometimes unsustainable for the vessel owner and barge operator. This is due to different factors such as the transport supply, transport demand, stiff competition from other transport modes and the varying water levels. According to Sys et al., (2020), freight prices in France and Belgium are often lower than other countries with IWT in Western Europe. The possible reasons for this according to the researchers is the combination of transport supply (which is often characterized by many smaller but older inland vessels as displayed in

Table ***1***), transport demand (which is often characterized by low-value goods) and the competition from other transport modes.

Table 1: West European dry cargo fleet (2015). Source (van Hassel, 2015)

Size	Number	Tonnage	Average age
<55 meter	755	321,910	78.18
<86 meter	2,619	2,933,584	59.15
>86 meter	1,009	2,865,284	14.94
Total	4,383	6,120,778	

The nature of the Rhine ensures a widely varying water level across the different season in a year, meanwhile, vessels sailing along the river must adhere to a sailing depth which is usually determined by fixed tide gauges[c] installed along the Rhine. These gauges (especially the Kaub gauge) display erratic water levels as seen in the in
(water level for Kaub gauge). The figure further reveals that there is a frequent occurrence of extended low water level along the Rhine in recent years, with the year 2018 experiencing the longest period of very low water levels between 2003 and 2019. The impact of this can be seen in the drop in TEU transported for Netherlands, Germany and France in Figure 2.

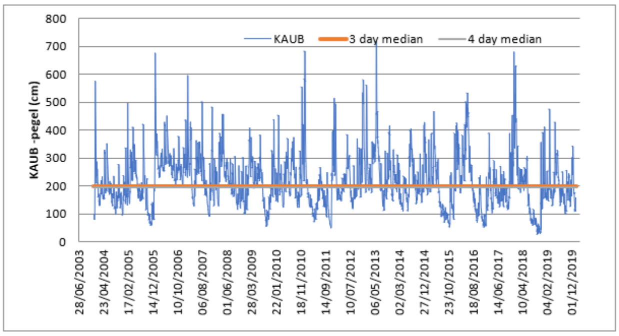

Figure 4: Water level along the Rhine (Kaub). Source: (Sys et al., 2020)

The frequent low water levels limit sailing possibility and reduce vessel capacity utilization, thereby making container shipping via IWT more difficult and expensive. To put this in perspective, it was reported in De Standaard that a drop in the water level below 2 meters will lead to an additional cost of 100 euros for a 12-metre container, whereas a drop below 1.8 meters will lead to an additional cost of 160 euros, and a drop below 1.6 meters will lead to an additional cost of 325 euros. This situation makes IWT less competitive with the other transport modes.

[a] The load factor is the ratio of the average load to the total vehicle freight capacity (containers, vans, lorries, train wagons, ships)

[b] The Rhine is both a glacier river (high water in the summer due to melting snow) and a rain river

[c] The two most important gauges along the Rhine are the Colgne guage (located along the Dutch-German border to Cologne) and the Kaub guage (located along Cologne to Basel).

Finally, there is the problem of planning, coordinating, scheduling and navigation of container barges. Due to the complexity involved in planning and coordinating the schedules of container barges in respect to terminal visits and the passing the locks and bridges, it becomes quite challenging to anticipate the next moves of the barges and adequately plan their schedules. To address this, effective management and cooperation of cargo flows, vessels, deepsea terminals and waterway infrastructure become necessary. This would ensure a compressed logistics system where individual stakeholder manages their operations and at the same time obtain information from the entire stakeholder's network.

4 Research Question

To address the different challenges of container barge transport and eliminate the inefficiencies that exist within the sector, two main research questions will be addressed;

- What new approaches/innovations could improve the current container barge logistics in seaports and terminals?
- How will these innovations improve container barge transport in Europe?

5 Research approach

To improve the current situation and increase the mode share of container IWT, a discrete event simulation (DES) model is being developed. This model can handle the complexity of IWT, where events occur in sequence and there is high uncertainty, constraint and interactions among different actors. The simulation will represent the logistics system operation over time and is capable to represent in detail the IWT container logistics chain from seaport terminals to the distribution centres, represent at a high-level, the road and rail network, and incorporate, process and demonstrate the impact of the different innovative ideas on the overall performance of the IWT container logistics chain. To achieve this, model architecture and system boundary are developed for the elements within the IWT sector. This is displayed in Figure 5.

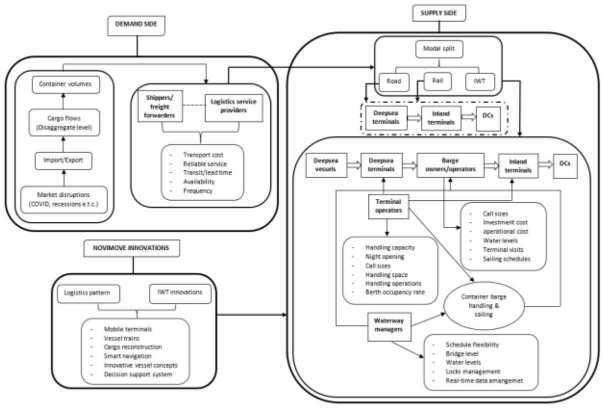

Figure 5: Model architecture and system boundary for container IWT

The model will simulate the current IWT container logistics system on the Rhine-Alpine corridor and give detailed analyses of the impact of the different innovations on the IWT container logistics.

References

Loos, R., & Jones, C. (2011). *Estimating the aquatic emissions and fate of perfluorooctane sulfonate (PFOS) into the river Rhine †*. (December). https://doi.org/10.1039/c1em10432b

Shobayo, P., & van Hassel, E. (2019). Container barge congestion and handling in large seaports: a theoretical agent-based modelling approach. *Journal of Shipping and Trade*, *4*(1). https://doi.org/10.1186/s41072-019-0044-7

Sys, C., Van de Voorde, E., Vanelslander, T., & van Hassel, E. (2020). Pathways for a sustainable future inland water transport: A case study for the European inland navigation sector. *Case Studies on Transport Policy*, *8*(3), 686–699. https://doi.org/10.1016/j.cstp.2020.07.013

This research is currently being conducted within the NOVIMOVE project (Novel inland waterway transport concepts for moving freight effectively) and is being funded by the European Union Horizon 2020 Program under grant agreement n° 858508.