

Smart Rivers 2019 Conference
/ September 30 - October 3, 2019
Cité Internationale / Centre de Congrès
Lyon FRANCE /

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Keywords:

Cost optimisation, Container transport, Vessel class selection, Cost indicators, Class IV, Class Va

Title:

**Optimal vessel class for container transport from hinterland to seaport,
costs comparison between Class IV and Class Va.**

Abstract:

Cost indicators for inland vessels indicate that larger container vessels sail at lower cost per TEU. The CEMT/ECMT recommends designing new inland waterways along the standards for CEMT Class Vb and to apply at least Class Va standards where a Class IV waterway needs to be modernised. However, in specific situations, a strong belief in “large is cheaper” results in higher costs compared to transport by smaller vessels. A case study has been performed for a specific transport of containers between an inland port in the northern part of the Netherlands and the Port of Rotterdam. The conclusion was that, for this specific transport, the transport with class Va is not more economic than with Class IV vessels. On the other hand, the side branch to the terminal is only a Class IV waterway and would need huge investment to bring it up to standards for Class Va.

Introduction

This paper presents a cost comparison between various vessel classes, with the focus on Class IV and Class Va vessels for the transport of containers between the hinterland in the Netherlands and the Port of Rotterdam. The cost indicator for inland vessels (RWS,2018) has been selected for the calculation of the transport costs. The cost indicator distinguishes various vessel classes and presents for each class the unit costs for sailing, waiting, etc. This cost indicator is updated on a regular basis and is generally accepted to be a realistic and reliable tool.

Waterway infrastructure

The main waterways in The Netherlands are modernized for Class V vessels. However, quite a few of the side branches that give access to the various container terminals are for Class IV or allow a limited draft and/or limited air-draft due to low bridges (RWS,2019). The EU (ECMT,1992) recommends that where a regional or Class IV waterway is to be modernised, the parameters should be adopted to at least Class Va.

The investment to provide larger vessels full access to inland terminals is huge. The works might include extension of the terminal, the enlarging (widening and deepening) of bends and straight sections of the canal, but also bridges and even locks. The cost for the civil works (excavation plus sheet pile for one bank) for upgrading a Class IV waterway to Class V are estimated at about 3 M€/km. However, actual cost might be much higher, depending on the available space and the additional work on bridges, locks and the terminal. Considering an investment in the waterway infrastructure that aims at a reduction of total costs, one should also investigate alternatives with smaller vessels.

Container vessels

Inland vessels have capacity varying from 24 TEU¹ for the smallest to 480 TEU for the largest vessels, The full TEU capacity can only be used under certain conditions of container weight, vessel draft and air draft.

Vessel Class (CEMT & RWS)	Class II/M2		Class III/M3		Class IV/M6		Class IV/M7		Class Va/M8		Class Va/M9		Class VIa/M11		Class VIa/M12	
Dimensions	m	TEU	m	TEU	m	TEU	m	TEU	m	TEU	m	TEU	m	TEU	m	TEU
Length / TEU per row	55	6	67	7	85	10	105	12	110	12	135	16	135	16	135	16
Beam/rows	6.6	2	7.2	2	9.5	3	9.5	3	11.4	4	11.4	4	14.2	5	17	6
Draft/layers	2.6	2	2.7	2	3.0	3	3.0	3	3.5	4	4.0	4	4.0	5	4.0	5
Airdraft (m)	5.25		5.25		7.0		7.0		9.1		9.1		12.0		12.0	
Vessels capacity	Tons	TEU	Tons	TEU	Tons	TEU	Tons	TEU	Tons	TEU	Tons	TEU	Tons	TEU	Tons	TEU
Cap (Tons and TEU)	540	24	750	28	1560	90	2020	108	3350	192	3950	256	4900	400	6000	480
Cost per hour	€/ hour		€/ hour		€/ hour		€/ hour		€/ hour		€/ hour		€/ hour		€/ hour	
Sailing (Loaded)	€53.25		€60.26		€92.47		€120.55		€150.13		€177.26		€215.39		€227.61	
Waiting (lock,bridge,port)	€39.23		€42.45		€65.37		€86.67		€101.25		€118.08		€136.90		€151.05	

Table with dimension, capacity and costs² (RWS,2018) of various vessels classes for container transport

Cost of sailing container vessels per TEU

The cost for sailing over a large distance (cycle of 2 * 500 km) have been calculated for the 8 vessels presented in the table above and divided by the capacity. The costs per TEU and per Ton have been plotted in graphs for two situations: for free air draft and for 7 m air draft that allows a maximum of 3 layers of containers.

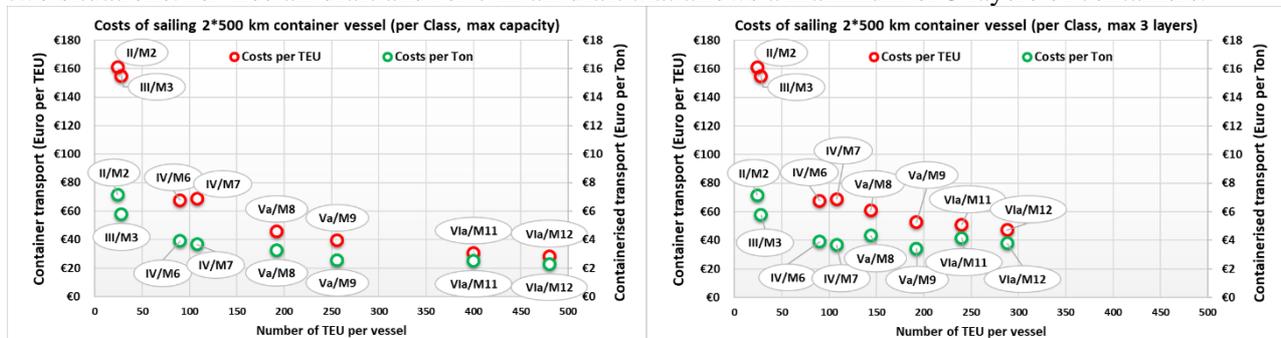


Figure with sailing cost of container vessel per TEU and per Ton (left free air draft; right max 3 layers)

The graph clearly indicates that in situation with free air draft, the sailing cost per unit decrease with increasing vessel size and that the largest vessel (Class VIa/M12) is the most economic.

For comparison the right figure indicates the effect of a limitation of the air draft to 3 layers. This maximum strongly limits the capacity in TEU for the largest vessels (Class Va and larger), where the sailing cost per TEU for vessel up to Class IV costs are unchanged. The sailing costs for the middle sized (Class Va) vessel, however, increase with 33% and for the largest (Class VIa) vessel even with 67%. This illustrated that air draft limitations have a very significant effect on the sailing costs per TEU. Other factors that affect the sailing cost per TEU are the maximum allowed draft and the average weight of the container per TEU.

Total cost of container transport.

The total costs for container transport include not only the cost for sailing but also the time for container handling and waiting (e.g. for bridge to open, for a navigation lock or near the terminal). In a real case, the trends can therefore differ from those set out for the cycle above, putting larger vessels at a disadvantage. For example, for the large vessels not only is the cost per hour high, but the handling time at the terminal is also high due the larger number of TEU per vessel.

The total cost per TEU have been calculated based on the total transport cycle, considering the number of TEU per vessel being the maximum number in view of the limitations of the transport route.

One transport cycle from the hinterland to the Port of Rotterdam and vice versa comprises:

1. container handling (unloading and loading containers) at the terminal in the hinterland;
2. sailing with sea-bound containers to the Port of Rotterdam;
3. container handling (unloading and loading containers) at various terminals in PoR; and
4. sailing back with land-bound containers to the terminal in the hinterland.

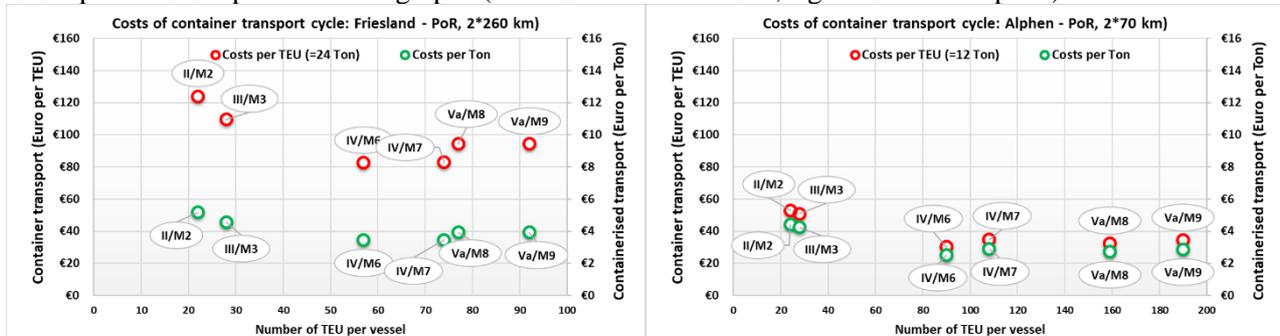
¹ TEU: Twenty-foot Equivalent Unit (standard container with a length of 20 feet or 6,2 m)

² Total of Fixed and Variable Costs for sailing and waiting, that includes cost for labour, fuel, and all other costs.

The container handling time at the terminals has been applied according to sailing schedules from container vessels in operation (e.g. from AIS). The sailing time to the PoR has been calculated with the “The Blue Road Map” (BVB,2019) a tool developed by the inland navigation branch organisations made available through internet. For two specific cases the cost per TEU have been presented below:

1. Friesland (e.g. Heerenveen, Leeuwarden, or Drachten): maximum draft 2.75 m, 24 Ton/TEU (agriculture products), sailing distance approximately 260 km.
2. Alphen: maximum draft 2.8 m; sailing distance approximately 70 km.

Costs per TEU are plotted in the graphs (left 260 km to Friesland, right 70 km to Alphen).



Surprisingly, the vessel costs for the transport with Class Va vessels are equal or even higher than with the 85 m long Class IV/M6 vessels. The main reasons are that for large vessels the draft limitation is larger and the time at the terminal is significantly longer than for smaller vessels. Especially for transport over short distances, the vessel costs for the terminal handling are a significant part for the total transport cost: e.g. for Class Va vessel transporting over 70 km, 60% to 70% of transport costs is related to the time at the terminals.

Conclusion

The conclusion of the study is that the selection of vessel class should not be based on the cost indicators only, but include the total transport cycle, because the costs per cycle are strongly influenced by:

- Transport distance and sailing time.
- The costs for the (sea) terminal handling, especially for transport over short distances.
- The effect of air draft limitation on the TEU loading capacity of the container vessel.
- Draft limitation for the TEU capacity of the container vessel; and
- Weight per TEU.

Measures in the infrastructure to improve cost efficiency include:

- Increase maximum the free air draft on the container routes, allowing at least 4 layers of containers (including high-cubes); and
- Increase the maximum beam and draft on the container routes.

Measures from container operators to improve cost efficiency include:

- Reducing the time at the terminals, especially by increasing the speed of container-handling at the PoR.
- Increase the call-sizes per sea terminal (or reduce the number of terminal calls per transport cycle).
- Collect the containers for one sea terminal with one vessel from more than one inland terminal, instead of distributing the containers from one inland terminal over a number of sea terminals in the PoR.

Additional remarks:

- Smaller vessels require more departing vessels per week and offer thus more flexibility.
- Largest inland terminal in the Netherlands (Alphen: 175,000 TEU/yr) is Class IV waterway (BVB,2015)
- Up to a vessel length of 86 m (Class IV/M6), only 2 nautical staff are required.

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