CBA Markiezaat Container Terminal

Analysis of the social costs and benefits - final

Rotterdam, 14 January 2022

Summary

The Markiezaat Container Terminal (MCT) is currently located in Bergen op Zoom at the Vierlinghweg. Total capacity of the terminal is around 140,000 TEU/year. A new site is being developed south of the Burgemeester Peters lock which gives direct access to the Scheldt-Rhine Canal. Total capacity at the new site is around 250,000 TEU/year.

MCT has initiated a project to modernize the future location of the terminal adhering to EU policy objectives to decarbonise the maritime industry. More specifically, the terminal will be modernised by means of the following terminal facilities:

- Total quay length will be 425 metres (325 metres extra compared to the BAU).
- Handling equipment at the terminal will comprise a second quay crane (fully electric) which enables further growth of container transhipment.
- Provide Green Energy EV Barge infrastructure (Onshore Power Supply for moored vessels and 2MW Docking Station where electric powered barges can recharge their batteries in future) and 2 retrofitted vessels

MCT will apply for funding from the Connecting Europe Facility (CEF). A socio-economic cost benefit analysis of the project is one of the requirements in the application. MCT has engaged Ecorys ('we') to conduct a socio-economic cost benefit analysis for the project.

Approach

The socio-economic cost benefit analysis is based on the methodology as described in the CINEA Guide on economic appraisal for CEF-T (October 2021). This SCBA concentrates solely on costs and benefits related to the project.

Results

Table S.1 and S.2 summarise the results of the financial and social analysis. For the analysis a time horizon of 26 years (2021-2046) is used including the development phase.

Based on the data provided by MCT, the project has a negative financial business case (CBA). Assuming funding of € 16,1 million (NPV), the FNPV of the project is € 6.6 million with an FRR of 6.1%. Funding has a positive impact on the financial CBA, and covers for a large part the deficit in project revenues.

Table S.1 Results indicators financial CBA (without CEF-funding)

	Return on investment without CEF	Return on investment with CEF
Project investment cost	-33,352,711	-33,352,711
CEF contribution	-	16,091,355
Replacement cost	-1,702,422	-1,702,422
Project O&M costs	-6,153,598	-6,153,598
Total revenues	31,733,215	31,733,215
FNPV	**-9,475,515**	**6,615,840**
FRR	**1.8%**	**6.1%**

The results of the SCBA show that the project is economically viable, socio-economic benefits exceed the costs of the project.

Table S.2 Results indicators SCBA (without CEF-funding)

Outcome indicator	Amount
Total economic costs	€ 42,8 million
Total economic benefits	€ 47,6 million
Economic Net Present Value (ENPV) (discount rate 3%)	€ 4,8 million
Economic Rate of Return (ERR)	4.1%
Economic Benefits/Costs Ratio (EBCR)	1.11

(Social) transport costs savings are the largest economic benefit of the project. For this reason a sensitivity analysis has been performed: a 10% lower and a 10% higher modal shift related to the project. Table S3 presents the results of the sensitivity analysis.

Table S.3 Results indicators SCBA sensitivity analysis

Outcome indicator	Project	Sens. Low	Sens. High
Economic Net Present Value (ENPV)	€ 4,8M	€ 0,6M	€ 9.0M
Economic Rate of Return (ERR)	4.1%	3.1%	5.0%
Economic Benefits/Costs Ratio (EBCR)	1.11	1.01	1.21

NPV reduces to € 0,6 million, when 10% less modal shift is realised (ERR of 3.1%), the NPV increases to € 9,0 million (ERR of 5.0%) when 10% more modal shift is realised. Based on these results we conclude that even with pessimistic modal shift assumptions the Project is still beneficial for society.

Introduction

Background

The Markiezaat Container Terminal (MCT) is currently located in Bergen op Zoom at the Vierlinghweg. Total capacity of the terminal is around 140,000 TEU/year. A new site is being developed south of the Burgemeester Peters lock which gives direct access to the Scheldt-Rhine Canal. Total capacity at the new site is around 250,000 TEU/year. The map below shows the current and new location of the MCT.

Figure 1 Current and future site of MCT at Bergen op Zoom

The multimodal logistics platform of Markiezaat Vastgoed, operated by Markiezaat Container Terminal (MCT) on the Antwerp-Rotterdam inland water way trajectory at Bergen op Zoom has a unique position to facilitate the intermediate demand of efficient container transportation. The envisioned modernised facility will be located directly on the Scheldt-Rhine Canal between the core sea ports of Rotterdam (about 100 km distance), Antwerp (about 30km distance) and Zeeland (about 70 km distance). These corridors are also visually presented in Figure 2.

Figure 2 Flemisch-Dutch Delta, including MCT at Bergen op Zoom

Source: MCT (2021)

How to read

In this report we describe the social costs and benefits of modernising the inland waterway transhipment capacity adhering to EU policy objectives to decarbonise the shipping industry.

The report starts with a description of the methodology of the social cost-benefit analysis (SCBA) and its application to MCT. We briefly outline the most likely situation that will arise if transhipment of the terminal will not be modernised (the Business As Usual or BAU), and the plans of MCT to modernise the terminal (The Project). The differences between the two situations result in the expected (social) effects, which form the basis of this SCBA.

Specifically, in the following chapters we will discuss:

- Chapter SCBA methodology : the explanation of the SCBA methodology and the principles of the analysis;
- Chapter Business as usual: the description of the BAU and the Project;
- Chapter Project Effects: the determination and valuation of the Project effects;
- Chapter CBA Outcome: the financial and social CBA results and their interpretation.

SCBA methodology

What is a SCBA?

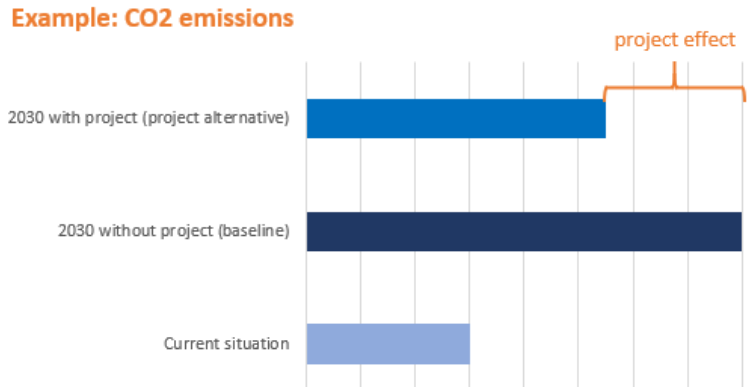
A SCBA describes the positive and negative effects of an investment on the prosperity of the Netherlands. This means that not only the effects for those stakeholders directly involved are looked at, but also the social effects for all stakeholders. This does not only concern financial costs and benefits, but also, for example, effects on travel time, and effects on the environment and climate. These effects are expressed in monetary terms (monetarisation) as much as possible. The ratio of all these costs and benefits gives a picture of the socio-economic return.

The SCBA is used to shape the 'social business case'. In other words, to answer the question: to what extent is it socially desirable to invest in modernisation of the MCT. A SCBA provides this insight as it compares the social costs with the social benefits.

Business as usual and project

To ensure an objective analysis of the modernisation of MCT, only effects that can be directly attributed to the modernisation should be considered. In the SCBA, the effects of modernisation the terminal site (The Project) are therefore compared with the effects in a business as usual (BAU) situation. The BAU refers to the most likely situation that occurs without the investments. It is important to realize here that in fact two future situations are compared. In this way, the SCBA only includes the effects that can be directly allocated to the modernisation of the inland barge terminal and are not considered autonomous effects. Figure 1 illustrates this by means of an example.

Figure 3 Illustration of BAU and Project

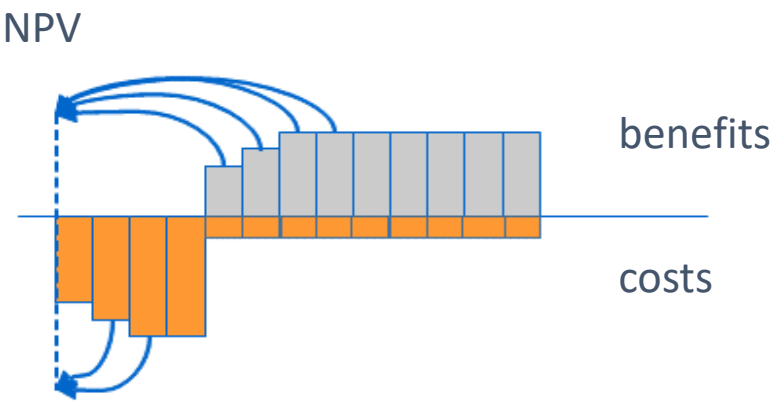


Source: Ecorys (2021)

Price level and interest rate

In a SCBA, the effects are expressed in euros (monetized) where possible. The costs and benefits are expressed in constant prices with a fixed price level (in this study 2021) and are included for a longer period. In order to compare the costs and benefits, these are calculated back to the first investment year (discounted) in a CBA. In this way a comparison can be made between effects that take place now and effects that take place in the future.

Figure 4 Illustration of discounting



NPV = net present value
Source: Ecorys (2021)

A fixed percentage per year is used; the interest rate. The DG REGIO methodology recommends a value of 5% in real terms for projects in Cohesion Countries and a value of 3% in real terms for other Member States. In accordance with the CBA Guide we use an interest rate of 3%.[1]

Time horizon

When determining the effects, the (economic) lifespan of the project is taken into account. For infrastructural projects, a reference period of 100 years is often used in SCBAs. For terminal projects normally a shorter period is applied, because it can be expected that modernisation of the terminal will have its welfare effects within this period. In accordance with the CBA Guide we use a reference period of 25 years (2021 – 2046) that is applied for the ports and airports sector.

In practice, the long-term effects have a limited influence on the results of a CBA. This is due to the discounting of effects. An extension of the life span therefore has a relatively smaller effect on the outcome.

Results of the CBA

The outcome of the SCBA is calculated in two ways:

- The net present value (NPV) is the balance of all discounted benefits minus costs. If the NPV is higher than zero, the project is profitable from a socio-economic perspective (and vice versa).
- The benefit-cost ratio (B/C) shows the ratio by dividing the discounted benefits by the discounted costs. A project with a B/C of 1 or higher is a profitable project from a social point of view (and vice versa).

Not all effects can be expressed in euros. Despite the fact that these effects are not monetized, they are social costs and benefits that lead to changes in prosperity. These effects are described qualitatively.

The monetized and the non-monetized effects must be considered integrally as the outcome of the SCBA.

[1] Guide to Cost-Benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, December 2014

Business as usual and project

Business as usual (BAU)

BAU refers to the most likely situation that occurs in the future without the project. In BAU the new location for MCT along the banks of the waterway Bergsche Diep at the municipality of Bergen op Zoom will be established in 2024. In figure 5 the new location of the MCT terminal is presented, including the expansion of storage locations Noordland 12 to 16 at the adjacent Noordland business park. In BAU a quay of 100 metres and only one quay crane (electric) is installed and two reachstackers will be used to handle containers. In BAU the terminal will refrain from investing in Green Energy EV Barge infrastructure (including Onshore Power Supply (OPS), a docking station for charging swappable batteries) and 2 retrofitted vessels (from conventional to electric powered).

Project

In the project the new MCT will also be established in 2024. The difference with BAU is that the terminal will be modernized adhering to EU policy objectives to decarbonise the maritime industry. More specifically, the terminal will be modernised by means of the following terminal facilities:

- Total quay length will be 425 metres (325 metres extra compared to the BAU).
- Handling equipment at the terminal will comprise a second quay crane (fully electric) which enables further growth of container transhipment.
- Provide green Onshore Power Supply (OPS) for moored vessels.
- Retrofitting two conventional vessels (diesel driven) to electric powered vessels.
- Provide a 2MW Docking Station where electric powered barges can recharge their batteries in future.

Figure 5 indication of the projected location

The investments are expected to take place in the period 2021-2025 and the new terminal will be operational from 2025 onwards. The terminal throughput will increase yearly, see table 1. The BAU and Project are in a schematic way summarised in Table 1.

Table 1 Overview of business as usual and project facilities

Business as Usual	Project
Quay length 100 metres	Quay length 425 metres
1 quay crane	2 quay cranes
Transhipment 156,000 TEU/year growing with 1% in year 1 to 3, and 0.5% following years	Transhipment 156,000 TEU/year growing with 15% in year 1, and 2% in following years
No Onshore Power Supply (OPS)	Facilitate Onshore Power Supply (OPS)
No retrofitted vessels	2 retrofitted vessels (electric powered)
No 2MW Docking Station (recharging batteries EV vessels)	Facilitate 2MW Docking Station (recharging batteries EV vessels)

Source: MCT (2021)

Project effects

In this chapter, the social costs and benefits of modernisation of MCT are presented. A distinction is made between direct, indirect and external effects of the project. First, a brief definition of the type of effects is obtained.

Direct Effects: Direct effects are the effects for the owner/operator and users of the project. This CBA then concerns, among other things, the investment costs in (such as transhipment equipment) but also the direct effects on transport costs (among others).

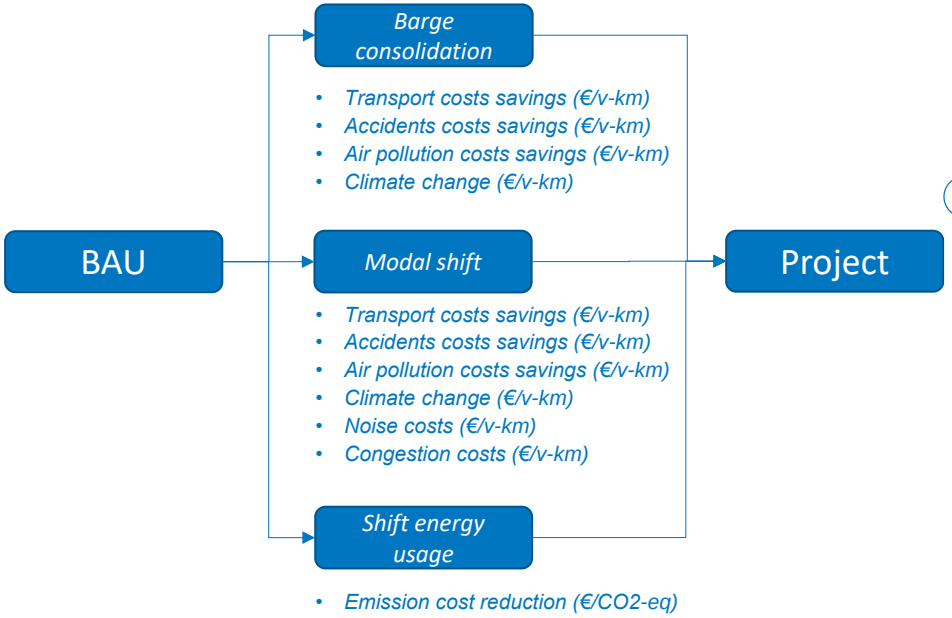
Indirect Effects: Indirect effects are effects that occur in other markets as a result of the passing on of the direct effects. Examples include the labour market as better accessibility can affect employment in an area or time savings.

External Effects: External effects are effects on goods for which there are no markets and for which there are therefore no market prices. This concerns, for example, emissions, noise pollution, road safety, damage to open space, barrier effect and cutting through the landscape.

Figure 6 presents an overview of all the effects of the project considered in the analysis, alongside the change that the project realises:

- Barge-Barge consolidation;
- A modal shift from truck to barge;
- shift in energy-use from conventional to (renewable) electricity.

Figure 6 Overview of project effects



Costs

Investment costs (CAPEX)

In the project situation the total quay length will be 425 metres instead of 100 metres in BAU. The extra investment costs are €18,2 million. Further, two quay cranes are installed for handling the containers compared to the investment of one quay crane in BAU. The investment costs of one quay crane is estimated at €4,0 million.[2]

MCT will also install Onshore Power Supply (OPS) for moored vessels, a 2MW Docking Station where electric powered barges can recharge their batteries in the future, and retrofitting two conventional to electric powered barges. Total investment costs are estimated at €10,5 million.

Finally, investment costs include costs for managing the project (€1,75 million), preparatory (legal) works (€1,15 million) and studies (€475,000).

Total investment costs (in K€) of the project are summarised in the following table.

Table 2 Investments (excl. VAT) per asset (in K€, price level 2021)

CAPEX item	Total	2022	2023	2024	2025	2026
Project Management	1,750	438	438	292	292	292
Container logistics ICT application	225	101	101	23	0	0
Permitting & legal work	1,150	395	345	337	37	37
Extended quay	18,152	20	20	18,072	20	20
Gantry crane	4,000	0	0	4,000	0	0
Study TEN-T road A4	250	0	0	125	63	63
Green Energy	10,466	100	155	10,211	0	0
Total	35,993	1,054	1,059	33,059	411	411

Source: MCT (2021), Zeeland Seaports (2010), Zero Emission Services (2021)

Replacement costs

The Project takes into account replacement costs[3] of €2,5 million in total (€0,5 million in 2030 and another €2,0 million in 2031).

Operational costs (OPEX)

The yearly extra operational costs include operational costs of an extra quay crane, comprising:

- Maintenance costs, estimated at € 30,000 for the first 5 years and after that the maintenance costs increase to 1.5% of the purchase price;

[2] MCT (2021), Price estimation for a Kuenz RMG crane.

[3] Replacement costs for docking station and batteries.

- Other operational costs comprise yearly staff costs for an extra quay crane operator € 60,000 and yearly energy costs € 114,500 for an extra quay crane.

Other operational costs include:
- Maintenance of the 425m quay, extra costs is estimated at €75,000 yearly.
- Operational costs for the OPS, Docking Station, and the retrofitted barges, estimated at approximately €179,800 yearly.

The table below summarises the operational costs (OPEX) of the project.

Table 3 OPEX (excl. VAT) per asset (in €, price level 2021)

Asset	Maintenance	Operational
Quay crane	€ 30,000 (year 1-5) After 5 years: 1.5% of purchase price	Staff costs € 60,000 Energy costs € 114,500
Quay 425 metres	€ 75,000	Not applicable
OPS, Docking Station, retrofitted vessels	€ 179,800	Not applicable

Source: MCT (2021), Zeeland Seaports (2010), Zero Emission Services (2021)

Direct effects

MCT is – when investing in a second quay crane – able to ship containers more efficiently (consolidation) by means of barge-barge transhipment. Furthermore, MCT expects as a result of the project investment a significant modal shift to be reached. These containers are currently being transported via truck to and from the ports of Antwerp and Rotterdam. These two direct effects result in transport cost savings. The underlying rationale, assumptions and key figures will be described briefly in this section

Transport costs savings - Barge-barge consolidation

Barges from other inland terminals pass Bergen op Zoom as they sail to Antwerp. These barges always contain several containers for different terminals in the Port of Antwerp and Rotterdam. These containers can be consolidated at MCT, loaded into larger inland vessels and be transported to the port of Antwerp. The inland vessel that will then be unloaded in Bergen op Zoom can then be loaded with containers at MCT with the Port of Rotterdam as destination. In practice, this saves barge roundtrips between Bergen op Zoom and the Port Rotterdam and Antwerp. MCT estimates that in the first year after the modernisation of the terminal 6,000 TEU to/from the ports of Antwerp and Rotterdam can be consolidated, the equivalent of 25 barges. The projection is that these volumes will increase to 20.000 TEU in 2035. This means in practice that in 2035 roughly 80 barge roundtrips to the seaports are avoided. After 2035, the yearly growth rates of the company's throughput forecast (2% per year) are applied.

A recent study performed on behalf of the Netherlands Institute for Transport Policy Analysis (KiM) is used to monetize the freight trips (expressed in kilometers) to freight costs. [4] In

[4] Panteia (2021), Cost Figures for Freight Transport.

combination with assumptions regarding the travel distance of the inland vessels, these freight costs are used to determine the transport cost savings resulting from the efficient barge to barge consolidation. An overview of these key figures are presented in Table 4.

Table 4 Overview of key figures

Key figure	Unit	Value	Source
Freight costs			
Inland vessel (large)	euro p. km	€ 17,23	Panteia (2020)
Truck (Tractor & trailer)	euro p. km	€ 1,52	Panteia (2020)
Distance			
Markiezaat <-> Rotterdam	km	200	Google Maps
Markiezaat <-> Antwerp	km	60	Google Maps
TEU/container ratio	**TEU/container**	**1,7**	**Ecorys (2021)**
TEU weight	**Ton**	**10**	**Ecorys (2021)**

Source: various sources (see table)

The transport cost savings due to barge consolidation are estimated at €55,000 in 2025. These figures will increase with the yearly growth rates that are expected by MCT.

Transport costs savings – modal shift

With extra crane capacity more containers could potentially shift from truck to barge. The rationale behind this modal shift effect is twofold:

1. Because of the extra capacity, more containers of third parties can shift from road to barge. In the first year 4,675 TEU (estimated as 5% of the total potential) could potentially shift from truck to barge. This potential is expected to increase at the same pace as the total transhipment at MCT
2. An average of 21% of the containers offered at MCT is transported by truck. 11% of these containers are trucked as a result of the minimum call sizes in the seaports. With the consolidation at the new terminal, MCT could transport this 11% by barge. In the first year an extra 13,068 TEU could shift from truck to barge. This potential is expected to increase at 2% per year.

As transport by barge is cheaper than transport by truck, there is a welfare effect to be gained as shippers are able to reduce their transport costs. The transport cost savings are estimated at almost € 1.7 million in the first year.

Finally, with extra transhipment capacity (due to a second quay crane and longer quay), MCT can handle more containers compared to BAU and thus will receive extra revenues. After the first year difference in container handling with BAU will be approximately 22,000 TEU (extra containers handled), increasing to approximately 91,000 TEU. From a societal viewpoint extra revenues gained by MCT is not a benefit to society, because throughput at the MCT terminal is not driving demand. In other words, the additional throughput of MCT will be transported anyhow as other terminals will use this potential extra volume throughput in the BAU. Therefore, revenues are taken into account in the financial CBA (business case) but not in the social CBA.

External effects

Less environmental impact resulting from modal shift

Impacts of transport on the environment will decrease as a result of less transport due to consolidation of cargo and modal shift from truck to barge. Emissions can be saved because transport of containers can be organised more efficiently due to barge-barge consolidation (6,000 TEU in the first year, 25 vessel movements), and containers can shift from truck to barge (17,743 TEU in the first year).

Less transport by barge and truck means less impact on the environment in terms of greenhouse gasses (CO_2), air pollution, noise and accidents. In order to monetize the external effects values, we have applied the key figures in the handbook on the external costs of transport (CE Delft, 2019).[5] The following key figures (per ton-kilometre) have been used for transport in the Netherlands:

Table 5 External effects of inland waterways and truck (HGV) (in € p. ton-kilometre)

External effects	Inland waterways	Truck
Climate Change*	€ 0,002653	€ 0,006050
Air pollution	€ 0,01204	€ 0,00977
Noise	N/A	€ 0,004281
Transport safety	€ 0,000496	€ 0,009350

* Climate change is the equivalent of CO_2 emissions

Effects of OPS, Docking Station and retrofitted vessels

Installing Green Energy EV Barge infrastructure (OPS and Docking Station) and retrofitted two conventional barges will also result in less environmental impacts:

- OPS: When barges are docked for loading/unloading containers, Onshore Power Supply (OPS) can be used instead of using a vessels' own diesel generator. On average the loading/unloading process takes about 3.5 hours. Currently vessels use their own diesel generators. Using OPS will results in less emissions and less noise. This effect will be presented in qualitative terms (+).
- Docking Station: With the new location, MCT is located strategically on Rotterdam-Antwerp corridor. Vessels passing the Scheldt-Rhine Canal can recharge their batteries at MCT in future. The uptake of electric powered vessels is very low. CCNR estimates that in 2050 13-35% number of ships will be electric powered vessels. The effects will probably not be significant, as in an optimistic scenario a switch to electric powered vessels will start only from 2035 (the net present value of effects starting in 2035 will be very small in this CBA with 2021 as base year). This effect will be presented in qualitative terms (+).
- 2 retrofitted barges: The use of electric powered vessels instead of conventional (diesel) powered vessels, will result in less environmental impacts. Benefits are estimated at €113,800 in the first year. As conventional powered vessels will also become 'greener' with Stage V engines, the benefits are slightly decreasing over time.

[5] CE Delft (2019), Handbook on the external costs of transport

CBA Outcome

The results of the analysis are presented in this chapter. First, the financial CBA results are presented. Thereafter, the results of the SCBA are shown. Lastly, a sensitivity analysis is conducted to test the robustness of the results.

Financial CBA

First, the financial CBA is an analysis of the direct costs and benefits by the project owner. In other words it is the business case of the project. The results are presented hereafter in NPV. The results present the impact of funding. Assuming funding of €16,1 million (NPV), the FNPV of the project is € 6.6 million with an FRR of 6.1%. Funding has a positive impact on the financial CBA, and covers for a large part the deficit in project revenues.

Table 6 Results indicators financial CBA

	Return on investment without CEF	Return on investment with CEF
Project investment cost	-33,352,711	-33,352,711
CEF contribution	-	16,091,355
Replacement cost	-1,702,422	-1,702,422
Project O&M costs	-6,153,598	-6,153,598
Total revenues	31,733,215	31,733,215
FNPV	**-9,475,515**	**6,615,840**
FRR	**1.8%**	**6.1%**

Socio-economic CBA

Second, we present the results of the SCBA. The following table provides an overview of the balance of costs and benefits for the period 2021-2046. Costs and benefits are expressed in the net present value on January 1, 2021 (price level).

Table 7 Results indicators Social CBA

Project investment cost	-33,983,541
Replacement cost	-1,871,396
Project O&M costs	-6,994,470
Total economic costs	-42,849,407
Barge to barge consolidation	2,238,255
Modal shift - truck traffic decrease	41,952,617
Modal shift - inland waterways traffic increase	-6,626,586
CO_2 emissions - truck traffic decrease	2,838,549
CO_2 emissions - inland waterways traffic increase	-824,496
Noise - truck traffic decrease	2,008,497
Noise - inland waterways traffic increase	-
Air pollution - truck traffic decrease	4,584,985
Air pollution - inland waterways traffic increase	-3,741,545
Transport safety - truck traffic decrease	4,387,132
Transport safety - inland waterways traffic increase	-154,002
Net value of electric barges compared to conventional barges	988,265
Total economic benefits	47,651,670
ENPV / Net benefits	**4,802,263**
ERR	**4.1%**
B/C RATIO	**1.11**

The total project investments (CAPEX and OPEX) are equal to € 42.8 million. The direct effects – expressed in transport costs savings – of the project are estimated at € 37,6 million.

Together with the positive external effects, resulting from the consolidation, modal shift and electric barges, the total social effects in terms of NPV amount to € 47.7 million. The external effects have a share of 21% (€ 10.1 million) during the project time horizon. The balance of income and costs amounts to € 4.8 million in NPV and the income/expense ratio is 1.11. The project is therefore profitable in terms of social costs and benefits.

Sensitivity analysis SCBA

A sensitivity analysis has been performed to explore the effects of changing key value drivers on the results of the SCBA. From the project SCBA results we learned that effects related to the modal shift (transport costs savings and social transport costs savings) have a large impact on the net results. For this reason a sensitivity analysis has been performed.

We calculate a low and a high scenario for the modal shift related to the project. The low scenario describes 10% less modal shift from truck to barge, while the high scenario describes a 10% higher modal shift. The following table presents the results of the sensitivity analysis.

Table 8 Results indicators SCBA sensitivity analysis

Outcome indicator	Project	Sens. Low	Sens. High
Economic Net Present Value (ENPV)	€ 4,8M	€ 0,6M	€ 9.0M
Economic Rate of Return (ERR)	4.1%	3.1%	5.0%
Economic Benefits/Costs Ratio (EBCR)	1.11	1.01	1.21

The NPV decreases to € 0,6 million, when 10% less modal shift is realised (ERR of 3.1%) compared to € 4,8 million in the project. The NPV increases to € 9,0 million (ERR of 5.0%) when 10% more modal shift is realised. Based on these results we conclude that even with pessimistic modal shift assumptions the Project is still beneficial from a welfare perspective.

References

- CE Delft (2019), Handbook on the external costs of transport
- CBS (2021), Consumer prices
- Guide to Cost-Benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, December 2014
- MCT (2021), Price estimation for a Kuenz RMG crane
- Panteia (2021), Cost Figures for Freight Transport
- Zeeland Seaports (2010), Haalbaarheidsstudie walstroom binnenvaart en zeevaart.
- Zero Emission Services (2021), Project estimate on the basis of operators

Annex

Calculations and assumptions

Direct and external effects

The direct effects are based upon reduction of road transport to inland waterways. A schematic calculation example is provided below:

$$\Delta\ Climate\ change = (\Delta\ Distance_{road} * Ton_{road} * Freight\ cost_{road}) - \\ = (\Delta\ Distance_{IWT} * Ton_{IWT} * Freight\ cost_{IWT})$$

The external effects are based upon the expected consolidation and modal shift from road transport to inland waterways. A schematic calculation example is provided below:

$$\Delta\ Climate\ change = (\Delta\ Distance_{road} * Ton_{road} * Price\ CO2\ p.tonkm_{road}) - \\ = (\Delta\ Distance_{IWT} * Ton_{IWT} * Price\ CO2\ p.tonkm_{IWT})$$

The different steps taken to monetize the external effects will be briefly described.

Step 1: Distance per modality

- In total, 4.675 TEU will be transported via inland vessels instead of transport by truck. These containers are transported in 38 movements by inland vessels, whereas there are 2.750 truck movements needed to transport the same number of containers.
- The average distance of a roundtrip to the Port of Rotterdam and Antwerp is respectively 200 and 60 km.
- The allocation of movements is assumed to be 50-50 between the Port of Rotterdam and Antwerp.

Step 2: Tonnes per modality

- The number of ton per TEU is assumed equal to 10.
- The capacity of an inland vessel is 122 TEU and a truck is able to transport 2 TEU

Step 3a: Freight costs per modality

In order to monetize the savings in freight transport, we have applied the key figures (€ p. vehicle kilometre) of a recent study on behalf of the Netherlands Institute for Transport Policy Analysis (KiM)

Key figure	Unit	Value	Source
Freight costs			
Inland vessel (large)	euro p. km	€ 17,23	Panteia (2020)
Truck (Tractor & trailer)	euro p. km	€ 1,52	Panteia (2020)

Step 3b: Value of external effects per modality

In order to monetize the external effects values, we have applied the key figures p. ton kilometre in the handbook on the external costs of transport (CE Delft, 2019).

Table 3 External effects of inland waterways and truck (HGV) (in € p. ton-kilometre)

External effects	Inland waterways	Truck
Climate Change*	€ 0,002653	€ 0,006050
Air pollution	€ 0,01204	€ 0,00977
Noise	N/A	€ 0,004281
Transport safety	€ 0,000496	€ 0,009350