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# **Cost Figures for Freight Transport – final report**

## ***Kostenkengetallen voor Goederenvervoer - eindrapportage***

**This study was commissioned by the Netherlands Institute for  
Transport Policy Analysis (KiM)**

***In opdracht van het Kennisinstituut voor Mobiliteitsbeleid (KiM)***

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# 1. Introduction

## 1.1 Background

This report presents the results, methods and data of the study *Kostenkengetallen Goederenvervoer* or Cost Figures for Freight Transport (hereafter: CFFT). This study on the cost development for the five main modes of freight transport was commissioned by the *Kennisinstituut voor Mobiliteitsbeleid* (Netherlands Institute for Transport Policy Analysis; KiM). KiM is part of the *ministerie van Infrastructuur en Waterstaat* (Dutch Ministry of Infrastructure and Water Management; IenW). The study was carried out by research institute Panteia.

This report forms the second phase of the study, and serves to present the end results as well as to provide insight into data (sources), methodology and more. In the first phase we have collected cost data for the five main freight transport modes through desk research and interviews. We used the data to calculate the CFFT for base year 2018, and we have also calculated the cost development for 2016-2018, by means of indexation of the figures of the base year. The results of the first phase were presented to KiM in the form of Microsoft Excel spreadsheets containing CFFT and cost development figures, which are also present in this report. These spreadsheets can be consulted online on the KiM website: [www.kimnet.nl](http://www.kimnet.nl)

## 1.2 Objectives and motivation

The main objective of this study is to provide insight into the absolute and relative costs of the five main freight transport modes in the Netherlands: inland waterway transport, road transport, maritime transport, railway transport and air freight transport. CFFT are used to determine the absolute and relative size of all cost components. By means of indexation of the figures of the base year (2018) to earlier years, cost development was determined as well.

In order to get an accurate picture of cost development of freight transport, it is important to periodically update the data, figures and indices. For each transport mode in the Netherlands, cost figures similar to CFFT have been collected and/or calculated before. But there are discrepancies in the frequency and level of detail between the freight transport modes. For instance, Panteia annually publishes the cost figures and cost development indices for the Dutch road transport sector, whereas cost development indices for air freight transport were never published on a regular basis. *Factorkosten van het Goederenvervoer* (Factor Costs in Freight Transport), the first report on freight transport costs that encompassed all modes was published by NEA (Panteia), TNO and Transcare in 2004. The most recent report that provided cost indices and encompassed all modes except air freight transport was the *Kostenbarometer Goederenvervoer* (Cost Gauge for Freight Transport), published in 2016. However, the base year utilised in the *Kostenbarometer* was 2004, and the figures for the years up to 2015 were based on indexation. More information on this report can be found in the next paragraph. Due to the discrepancies in frequency, level of detail and transport modes covered in current publications, information on freight transport costs is highly fragmented.

As the latest complete transport cost figures stemmed from 2004, fourteen years behind the figures presented in this report, a thorough update was in order. Transport and logistics is a dynamic sector which generally faces low profit margins. As such, transport enterprises are wont to changing their practices, assets, resources et cetera quite often and at a rather high pace. This holds true for all freight transport modes, although rapid change is easier for some modes than for others – mainly depending on the life cycle duration of assets. For example, the average useful life period of a truck is 7-8 years, whereas the average maritime container liner has a lifecycle of 20-25 years – making it more difficult to replace with different types in the short term. Crucial for the course of transport cost development was the economic crisis of 2008-2014, as this event shifted attention from revenue maximization to cost minimization. Besides, digitization, automation, new business models,



emission reduction and changing labour and social practices have had a far-reaching effect. In short, the transport business in 2018 is nearly incomparable to that of 2004.

In conclusion, information on freight transport costs and their development is fragmented, incomplete and partially out-dated. Political decision-makers, transport policy researchers and freight transport modellers depend on freight transport cost data to be able to conduct their work effectively and efficiently. As such, there exists an urgent need for up-to-date, complete and transparent Cost Figures for Freight Transport. Therefore, KiM has commissioned Panteia to collect, calculate and report new CFFT in this study.

### 1.3 Relation to *Kostenbarometer* (2016)

The *Kostenbarometer* is a study that has been conducted periodically from 1980 onwards, with the aim of mapping transport cost development. It was updated last in 2016. *Steunpunt Economische Expertise* (Support Center for Economic Expertise; SEE) and KiM commissioned the study and it was carried out by Panteia. SEE is part of Rijkswaterstaat (Directorate-General for Public Works and Water Management; RWS), which is in turn part of IenW. The final product was not a report, but a series of spreadsheets that contain cost development information for four transport modes: inland waterway, road, railway and maritime. As stated above, the data is represented as index numbers, with the base year set at 2004. The spreadsheets provide cost development index numbers for the extensive period of 1980-2015. The newest version also contains background information on data collection and data processing. The figures in the *Kostenbarometer* are based on the data, assumptions and calculations used in the NEA (Panteia) *Factorkosten*-report from 2004. Data for 1980-2003 was collected beforehand, and that of 2005-2015 was calculated by indexing the figures from 2004.

The *Kostenbarometer* can be consulted online at:

<https://www.rwseconomie.nl/kengetallen>

Several differences exist between the *Kostenbarometer* and the current study. **The base year for indexing in the former was set at 2004, whereas the current base year is set at 2018.** Besides, the current study is more comprehensive than the *Kostenbarometer* in four ways. Firstly, it includes CFFT for the air freight transport mode, which were omitted prior. Secondly, the CFFT have been calculated on a more detailed level. Thirdly, the analysis in the *Kostenbarometer* was based on four types of cargo per freight transport mode, whereas this study also incorporates a division between ten commodity groups (besides the four types; see paragraph 2.1 for clarification). Fourth and finally, the current study contains more extensive explications on the methodology that was utilised for calculating the CFFT as well as the requisite data and figures.

### 1.4 Structure

This first chapter has provided a general overview of the background, aims and investigations preceding this report. In chapter 2, the methodology will be discussed in detail. This includes the segmentation of freight categories that was used as well as the general differences and similarities between modes regarding goods categorization, assumptions and other factors. The second chapter also contains an explication on the cost categories that make up the CFFT. Information in the second chapter applies to all transport modes.

Chapters 3 to 7 are each devoted to a single transport mode, and all follow the same format. The modes are: inland waterway transport (chapter 3), road transport (chapter 4), maritime transport (chapter 5), railway transport (chapter 6) and air freight transport (chapter 7). The chapters open with an introductory paragraph which provides general information related to that transport mode. The second paragraph of each chapter will detail the assumptions that were used for the calculations. Paragraph 2 also documents the consulted information sources. These assumptions concern non-cost data, like vehicle types, commodity groups and transport figures. Paragraph 3 of



each chapter contains data and assumptions on cost constituents and factors, as well as documentation of related information sources. Note that the cost methodology in paragraph 3 also documents the methodology and sources for the cost development shown in paragraph 5 of each chapter. The fourth paragraph provides the final remarks on methodology specific to that mode, if applicable. Paragraph 5 presents the actual CFFT, with 2018 as the base year. The CFFT in this paragraph are presented for each of the (four) types of cargo. The CFFT for each of the ten commodity groups can be found in the corresponding appendices for the inland waterway, road and rail transport modes. Finally, the sixth paragraph is devoted to the cost development of each freight transport mode for the period 2016-2018. Cost development was mainly calculated by indexation of the figures of the base year (2018). The figures in paragraph 6 of each chapter show the mutation of freight transport costs between the yearly averages from 2016 to 2017 and from 2017 to 2018, in terms of percentage. These mutations also can be used to calculate absolute transport costs for 2016 and 2017.

The appendices contain lists of extended cost data tables for certain transport modes (A-C) and a glossary (D). The final two appendices (E and F) contain additional information used for the inland waterway transport and railway transport modes respectively.



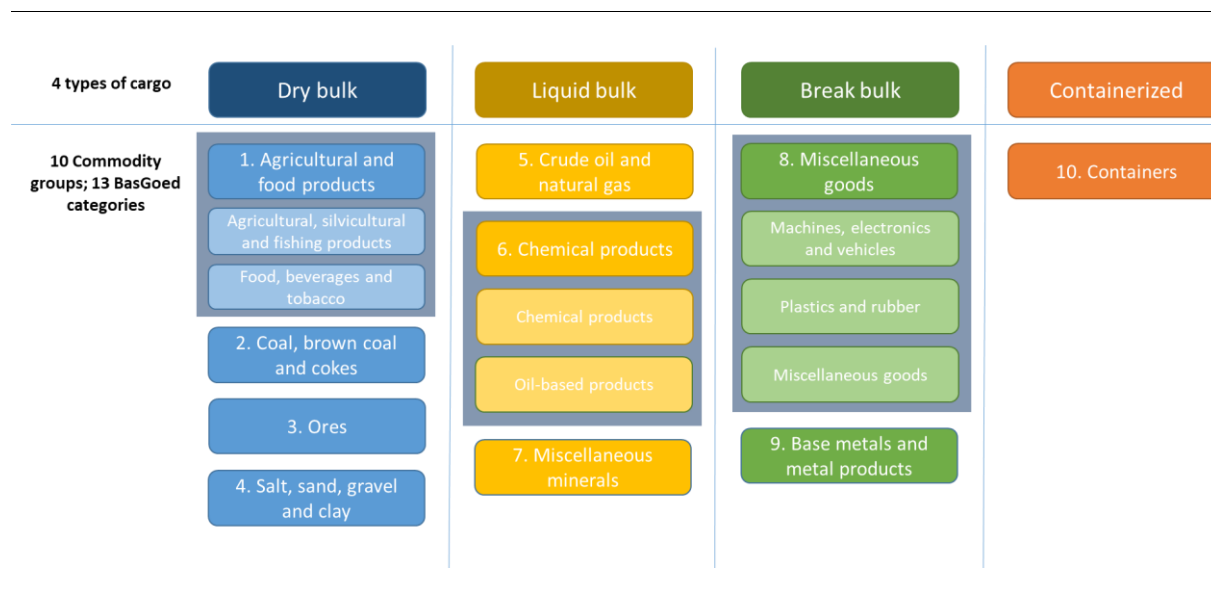
## 2. Segmentation and Methodology

This chapter sets out and details the methodological principles and assumptions that are relevant for every freight transport mode. Paragraph 2.1 pertains to the relation between goods categories, transport modes and vehicle types, and explains how we arrived at the final segmentation used in calculating the CFFT. The next paragraph, 2.2, contains general remarks on methodology and data that are not mode-specific. Finally, paragraph 2.3 contains general remarks on CFFT calculation methodology.

### 2.1 Segmentation and relation to transport modes

The transport sector handles many different types of goods, each having its own requirements and/or restrictions. The main physical characteristics that transportable goods may have form the starting point: dry bulk, liquid bulk, break bulk and containerized freight. Next, these four are combined with categories of goods. BasGoed, the main strategic goods transport forecast model of RWS, denotes thirteen separate categories. For this study, we condensed several of these to reduce complexity: from thirteen categories to ten commodity groups. Other classifications or distinctions could be made, but we chose to regard only those relevant to calculating transport costs and CFFT. See figure 2.1.

Figure 2.1 The relation between the four main cargo types and the 10 commodity groups we utilise for the analysis. (The squares with lighter coloration and lacking a number belong to the 13 BasGoed categories, and are assimilated into the 10 commodity groups. The gray areas denote which BasGoed categories are assimilated into which of the 10 commodity groups.)



Source: Panteia

Every freight transport mode is suited for hauling specific commodity groups, but unfit for others. For every mode, we have selected one or more specific vehicle type(s) as a basis for our analysis. The relations between main goods types, transport modes and vehicle types are shown in table 2.1.



Table 2.1 Overview of viable combinations between freight transport modes, vehicles and the four main types of cargo. Green squares denote that vehicles are able and utilised to transport goods within a category; red squares denote that a vehicle is not or barely used for that cargo type.

Mode	Vehicle types	Main type of good				
		Non-containerized				Container
		Dry bulk	Liquid bulk	Break bulk	N.a.	Container
Road	Truck	Green	Red	Green	Red	Red
	Truck with extra trailer	Green	Red	Green	Red	Red
	Tractor-trailer	Green	Red	Green	Red	Red
	Delivery van	Red	Red	Green	Red	Red
	Tractor solo	Red	Red	Red	Green	Red
	Specialised vehicle	Red	Red	Red	Green	Red
	LZV (longer, heavier truck)	Red	Green	Red	Red	Green
Railway	Train	Green	Red	Green	Red	Red
Inland waterway	Small	Green	Red	Green	Red	Red
	Medium	Green	Red	Green	Red	Red
	Large	Green	Red	Green	Red	Red
	Pushbarge	Green	Red	Red	Red	Red
Maritime	Carrier	Green	Red	Green	Red	Red
Air	Cargo aircraft	Red	Red	Green	Red	Red

Source: Panteia

The second paragraphs of subsequent chapters provides further explanation as well as details on and justification for the selection of specific vehicle types. The road and inland waterway modes feature several vehicle types based on load capacity and/or the commodity groups they are used for. Three different variations of the same vehicle type are used in the maritime and railway modes, as these are each tied to specific main goods types. See paragraph 2 of the corresponding chapter (5 and 6 respectively) for further details. Air freight transport consists of two main methods of operation: full freighter and belly transport. Belly transport denotes the practice of using excess capacity in aircraft's holds on passenger flights to transport air freight. For calculating CFFT, we chose to disregard belly transport as its costs are nearly impossible to distinguish from passenger transport costs. In full freighter transport, the total number of vehicles (cargo aircraft) is very low, and 75% of these are of the same model. Therefore we analysed a single vehicle type for air freight transport.

Table 2.2 provides the same overview as Table 2.1, but now for the ten commodity groups from figure 2.1. Every green square signifies a type of transport that is common and therefore specifically included in the CFFT.



Table 2.2. Overview of viable combinations between freight transport modes, vehicles and the 10 commodity groups.

Mode	Vehicle types	Main types										
		Non-container										Container
		Agricultural and food	Coal, brown coal and cokes	Ores	Salt, sand, gravel and clay	Crude oil and natural gas	Chemical products	Miscellaneous minerals	Miscellaneous goods	Base metals and metal products	N.a.	
Road	Truck	Green	Red	Red	Green	Red	Red	Red	Green	Red	Red	Red
	Truck with extra trailer	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	Tractor-trailer	Red	Red	Red	Red	Red	Green	Red	Red	Red	Red	Red
	Delivery van	Red	Red	Red	Red	Red	Red	Red	Green	Red	Red	Red
	Tractor solo	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Red
	Specialised vehicle	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Red
	LZV (longer, heavier truck)	Red	Red	Red	Red	Red	Green	Red	Green	Red	Red	Green
Railway	Train	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green
Inland waterway	Small	Green	Green	Green	Green	Red	Red	Red	Green	Green	Red	Green
	Medium	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green
	Large	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green
	Pushbarge	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Maritime	Carrier	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Air	Cargo aircraft	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

Source: Panteia



## 2.2 General methodological and data-related principles

Information in this paragraph applies to all four main cargo types, ten commodity groups, five modes and all vehicle types. Every subsequent chapter (3-7) will feature sections on the assumptions for calculations within that mode and an overview of the sources for the cost data. These are followed by paragraphs devoted to providing general information and specific methodology relevant to that mode and chapter.

The CFFT and other (cost) figures in this report are based on information collected from transport operators operating in the Netherlands. **The data on the road, inland waterway and air modes is based exclusively on Dutch companies. The data on the railway and maritime modes is based on data from both Netherlands-based companies as well as foreign companies that operate in the Netherlands.** This is due to the nature and structure of railway and maritime transport operators. Panteia was responsible for collection of the data through desk research and interviews. For several transport modes, we relied on our existing databases of cost figures and cost developments (as these are annually collected within our network). The CFFT in this report are calculated based on the cost level for the full year of 2018. The figures for every cost category (see paragraph 2.3), are either taken directly from the data or are calculated based on the data. For this study, there is no need for distance-related distinctions between transport modes, vehicles or trips (e.g. long haul or last-mile transport). The reason is that we break down all costs into fixed and variable cost categories. **When utilizing the CFFT for calculating the costs of a trip, one can simply add the proportional fixed costs (based on the amount of time needed for the trip) to the variable cost per kilometre multiplied by the distance.**

**Cost figures in this report are based exclusively on transport for hire and reward – freight transport of goods on behalf of third parties by dedicated operators. Own-account transport, which is performed by manufacturing and retail companies as an ancillary part of their business, has been omitted from analysis. No investigation into absolute or relative cost levels for own-account transport has not been conducted, but cost levels in own-account transport can be assumed to be similar to those in transport for hire and reward.**

The CFFT presented in this report are in essence market averages. This is because we assume that the transport sector as a whole bases its cost price on healthy market and corporate practice. On the level of individual companies and itineraries, deviations may occur.

Besides cost data, we have also collected other figures required for calculating CFFT. Note that these figures rely on the vehicle type(s) that we have selected for each freight transport mode. Specifications and justification for the selection of each model can be found in the third paragraph of each subsequent chapter. The calculations based on the combination of cost and other data are listed in paragraph 2.3. The non-cost data consists of:

- Vehicle type
- Distance travelled (km)
- Time in use (hr)
- Navigation time (hr)
- Time (un)loading (hr)
- Carrying capacity (tonne)
- Average tonnage (tonne)

Three types of figures require a more detailed explanation to avoid confusion.



#### Distance travelled while loaded (%)

This figure denotes the percentage of distance travelled while loaded with cargo (in km) compared to the total distance travelled (km) by one or more freight transport vehicle(s). Note that the load factor is irrelevant; only whether or not the vehicle was loaded matters for this statistic. For example: if this percentage is 60% for a truck on a 10 kilometre itinerary, this truck was carrying freight for six out of ten kilometres. It was running empty for the other four kilometres.

Formula: distance travelled while loaded with cargo / total distance travelled

#### Load factor (%)

The load factor is the ratio between available capacity of a vehicle and cargo carried by that vehicle. In this report, load factor is based on weight (in tonnes), rather than distance or volume. Additionally, we have calculated the load factor based on total transport figures for the year of 2018, rather than for individual itineraries or vehicles.

Formula: average tonnage / carrying capacity

#### Utilisation rate (%)

The utilisation rate is an important indicator of transport efficiency. It provides a percentage that denotes the utilisation of available transport capacity based on both distance travelled and carrying capacity.

Formula: Distance travelled while loaded (%) \* load factor (%)

### **2.3 Composition of Cost Figures**

In this report, we discern five main cost categories when calculating CFFT, each with its own subcategories. The approach is to be as exact as possible. This leads to several different subcategories per transport mode, as practical realities and bookkeeping practices differ per transport mode. The level of detail within the cost (sub)categories of the CFFT is dependent on the availability and/or level of the data. The list below provides an overview of the five main cost categories and an indication of their subcategories and other cost types that fall within:

- Fixed costs:
  - Asset depreciations or asset leases (mutually exclusive)
  - Insurance
  - Interest
  - Maintenance and repairs (x%)
- Variable costs:
  - Fuel / energy
  - Bunkering
  - Stores and supplies
  - Maintenance and repairs (x%)
- Staff costs (on-board personnel):
  - Wages
  - Social security and pension contributions
  - Accommodation costs
- Mode-specific costs:
  - Usage of infrastructure
  - Supporting services
  - Permits and certification



- General operating costs:
  - Administration
  - Real estate and infrastructure
  - Wages including social charges for other personnel
  - IT and communications
  - Overhead

Splitting total costs into five categories facilitates calculations, as well as providing a deeper understanding of the cost structures specific to each transport mode. Of the latter three cost categories, only the cost subcategories of mode-specific costs vary based on utilisation of vehicles. Increased utilisation leads to increased requirements for usage of infrastructure (runways, ports, etc.) and supporting services (bunkering, outsourced cargo handling, etc.). As such, the mode-specific cost category is considered variable whereas staff costs and general operating costs are considered fixed cost categories.

As stated above, several annual (average) cost figures can be calculated. These require a combination of the cost data in this paragraph and the distance- and time-related data from the previous paragraph:

- Total annual cost = fixed costs + variable costs + staff costs + mode-specific costs + general operating cost
- Cost per kilometre = total annual costs / distance travelled (km)
- Cost per hour = total annual costs / time in use (hr)
- Cost per tonne-kilometre = total annual costs / (distance travelled (km) \* average tonnage)
- Cost per ton per hour = total annual costs / (time in use (hr) \* average tonnage)
- Cost of waiting and (un)loading per hour = (fixed costs + staff costs + general operating cost) / time in use (hr)



## 3. Inland waterway transport

### 3.1 Introduction and general information

Inland waterway transport, also called inland navigation or inland shipping, signifies freight transport with ships between inland ports via inland waterways. The inland waterway system in the Netherlands is extensive, and consists of a large number of canals, rivers and lakes. Various forms of infrastructure have been constructed to improve navigability and efficiency, including locks, terminals and dams.

A large number of ship sizes and models exist, but for the purpose of this analysis we have selected four main categories: small ships, medium ships, large ships and push barges. A push barge is a freight transport vessel without its own propulsion, and is pushed by another ship. Figure 3.1. provides an overview of the existing segments for the inland waterway mode.

Figure 3.2 The four types of vehicles analysed for the inland waterway mode and the commodity groups they transport. The colour scheme follows the same principle as in figure 2.1: blue signifies dry bulk, yellow signifies Liquid bulk, green signifies break bulk and orange signifies containerized cargo.

Small ships	Medium ships	Large ships	Push barges
Agricultural and food products	Agricultural and food products	Agricultural and food products	Agricultural and food products
Coal, brown coal and cokes	Coal, brown coal and cokes	Coal, brown coal and cokes	Coal, brown coal and cokes
Ores	Ores	Ores	Ores
Salt, sand, gravel and clay	Salt, sand, gravel and clay	Salt, sand, gravel and clay	
Miscellaneous goods	Crude oil and natural gas	Crude oil and natural gas	
Base metals and metal products	Chemical products	Chemical products	
Containers	Miscellaneous minerals	Miscellaneous minerals	
	Miscellaneous goods	Miscellaneous goods	
	Base metals and metal products	Base metals and metal products	
	Containers	Containers	

Source: Panteia



## 3.2 Assumptions

This paragraph presents an exhaustive overview of the assumptions we used to calculate the CFFT for the inland waterway mode. The information sources utilised are listed in section 3.2.2.

### 3.2.1. Non-cost data

As described above, we have selected four vehicle types for this transport mode. These are taken from the ship classification system developed by RWS, and are mainly based on size and tonnage.

Data on ship sizes and the amount of ships in use for each classification were collected in Panteia (2017). Based on that data, we have determined the most frequently used model for all four ship sizes. Table 3.1 displays information regarding these four ship types:

Table 3.1. Ship types, models, classification and specifications. This is an excerpt of the ship classification system table by Rijkswaterstaat.

Ship size	Ship classification	CEMT-class	RWS-class	Capacity: bandwidth / average (tonne)	Dimensions: length / width (m)
Small	Kempenaar	II	M2	401-650 / 540	5,11-6,70 / ≥38,01
Medium	Rijn-Herne schip	Iva	M6	1.251-1.750 / 1.360	8,31-9,60 / 38,01-86,00
Large	Groot Rijnschip	Va	M8	2.050-3.300 / 2.410	9,61-11,50 / 38,01-111,00
Push barge*	4 bakduwstel*	VIb	BII-4	7.501-12.000 / 11.000	15,11-24,00 / 146,01-200,00

Source: Rijkswaterstaat (2017)

\* Push barges are large vessels without propulsion. They are generally utilised in convoys of several push barges fixed together and a push-tug ship for propulsion. In this report, we assume a convoy of four push barges and a single push-tug.

To acquire the complete dataset required for calculating CFFT for the inland waterway mode, the information in figure 3.1 and table 3.1 was combined with the 2018 data on average tonnage, average time in use and distance travelled for the four ship types. The exhaustive inland waterway transport database BIVAS, also by RWS, records load factor and the percentage of distance travelled while loaded for each vessel and itinerary. This allowed for the calculation of the data in table 3.2 for every listed combination of ship category and commodity group. The following formulas were used:

- Average tonnage = load factor \* maximum capacity
- Time in use is based on averages for each ship type. The average number of hours in use on a yearly basis has been calculated previously by Panteia (2017).
- Distance travelled = Utilisation rate \* average speed while carrying cargo + (1 - utilisation rate) \* average speed while not carrying cargo
- Utilisation rate (%) = distance travelled while loaded (%) \* load factor (%)



Table 3.2. Data on the inland waterway mode – the last three columns list average time, distance and utilisation rate for all ships of that type.

Ship type	Commodity group	Average tonnage (tonne)	Time in use (hr/yr)	Distance travelled (km/yr)	Utilisation rate (%)
Small	Agricultural and food products	244	3.830	19.869	45
Small	Coal, brown coal and cokes	249	3.830	19.835	46
Small	Ores	245	3.830	19.858	45
Small	Salt, sand, gravel and clay	235	3.580	22.007	44
Small	Miscellaneous goods	170	3.830	20.335	32
Small	Base metals and metal products	245	3.830	19.860	45
Small	Containers	89	3.830	23.943	17
Medium	Agricultural and food products	543	3.971	24.935	40
Medium	Coal, brown coal and cokes	626	3.971	24.642	46
Medium	Ores	568	3.971	24.848	42
Medium	Salt, sand, gravel and clay	591	3.999	27.583	43
Medium	Crude oil and natural gas	441	4.055	26.826	32
Medium	Chemical	435	4.055	26.853	32
Medium	Miscellaneous minerals	485	4.055	26.639	36
Medium	Miscellaneous goods	347	3.971	25.626	26
Medium	Base metals and metal products	599	3.971	24.737	44
Medium	Containers	339	4.679	34.002	25
Large	Agricultural and food products	868	4.318	32.315	32
Large	Coal, brown coal and cokes	965	4.318	32.143	36
Large	Ores	955	4.318	32.161	35
Large	Salt, sand, gravel and clay	1023	4.348	35.690	38
Large	Crude oil and natural gas	844	6.224	46.348	31
Large	Chemical	732	6.224	46.751	27
Large	Miscellaneous minerals	823	6.224	46.427	30
Large	Miscellaneous goods	656	4.318	32.694	24
Large	Base metals and metal products	971	4.318	32.132	36
Large	Containers	745	6.823	50.565	28
Push barge	Agricultural and food products	2955	8.064	113.582	27
Push barge	Coal, brown coal and cokes	4335	8.064	108.667	39
Push barge	Ores	3948	8.064	110.044	36

### 3.2.2. Information sources

- Organization:** Rijkswaterstaat  
**Title (NL):** BIVAS – Binnenvaart Analyse Systeem  
**Title (EN):** BIVAS – Inland waterway transport analysis system  
**Year:** 2009  
**Reference / link:** <https://bivas.chartasoftware.com/Home>
- Organization:** Rijkswaterstaat  
**Title (NL):** Richtlijnen Vaarwegen  
**Title (EN):** Waterway Directives  
**Year:** 2017  
**Reference / link:** [https://staticresources.rijkswaterstaat.nl/binaries/richtlijnen-vaarwegen-2017\\_tcm21-127359.pdf](https://staticresources.rijkswaterstaat.nl/binaries/richtlijnen-vaarwegen-2017_tcm21-127359.pdf)



- Organization: Panteia  
Title (NL): Kostenkengetallen Binnenvaart  
Title (EN): Cost Figures for Inland Waterway Transport  
Year: 2017  
Reference / link: <https://www.panteia.nl/nieuws/stijging-kosten-binnenvaart-zet-door-2018/>

### 3.3 Cost methodology

As stated above, (cost) figures for the inland waterway mode are collected periodically from Dutch inland waterway transport operators. The comparison between figures from subsequent years has been used to determine cost development (see paragraph 3.6), although for several (sub)categories we have drawn upon other data. If applicable, this will be described in the corresponding section of this paragraph.

This paragraph presents an exhaustive overview of the methodology we used to determine the cost categories for this freight transport mode. The information sources utilised are listed below (section 3.3.6). Several sources listed in section 3.2.2 were consulted again for this paragraph, but are not listed again in this paragraph.

#### 3.3.1. Fixed costs

The cost types that belong to fixed costs are based on Panteia's inland waterways transport cost model. This is the same model used in the annual publication *Kostenontwikkeling Binnenvaart en Raming* (Cost Development for Inland Waterway Transport and Forecast). Within this model, costs are based on the carrying capacity and insured value of vessels. The insured value is based on assessments performed for several vessel types in 2018. The following list provides an overview of all cost components:

- Depreciations of capital assets (a)
- Interest over capital assets (b)
- Insurance costs (c)
- Maintenance and repairs; 50% of total (d)

##### 3.3.1a. Depreciation costs

The annual cost of depreciation per ship depends on three factors: the insured value, the residual value (alternatively: salvage value or resale value) and the economic life period. The formula is as follows:

Depreciation costs = (insured value – residual value) / useful life period

This formula deviates from the standard one used in business economics theory. Generally, business owners prefer to monitor the replacement value of a vehicle, rather than calculate depreciation costs based on the initial investment (i.e.: the insured value). However, we opted to utilise the insured value because this paints a more accurate picture of the replacement value of a ship. The actual market value of (used) ships constantly fluctuates due to supply and demand, making it unfit for calculating fixed costs on a per year basis. One caveat of our method is that we assume that ships are not under- or over-insured. Panteia has used information provided by insurance companies to determine the relation between insured value, load capacity and year of construction. The duration of the depreciation period (i.e.: useful life) varies between ten and twenty years based on the time in use (hr). The residual value of a ship type is based on the amount of iron used in the construction of the ship, which has to be multiplied with the current iron price.



Annual mutations of the insured value of ships served as the basis for determining the cost development of this subcategory. Data on the residual value of ships has been derived from an ancillary inquiry among inland waterway transport operators.

### 3.3.1b. Interest costs

The annual cost of interest per ship depends on six factors:

- The insured value of a ship
- The residual value of a ship
- The share of loan capital (alternatively: debt or outside capital)
- The share of equity
- The interest rate on loan capital
- The interest rate on equity

The total annual interest costs are calculated based on the average annual depreciated capital. The formula is provided below. Legend: insured value = IV; RV = residual value; E = equity; LC = loan capital. The share of equity is 4% and the share of loan capital is 96%.

$$\text{Interest costs} = \frac{IV+RV}{2} * ((0,04 * \% \text{ interest on E}) + (0,96 * \% \text{ interest on LC}))$$

The financing ratios between equity and loan capital are based on the figures of over 500 ships. These figures are collected regularly for the annual study Cost Development of Inland Waterway Transport and Forecast. We opt to include the interest on equity, as these are so-called 'opportunity costs', meaning these are proceeds that could have been gained had the equity been invested without any risk (e.g. in government bonds) rather than invested in a ship. The interest rate in our calculation is based on the average rate for long-term fixed rate loans in 2018. Cost development for this subcategory has been determined based on the average interest rate of the past five years. It is applicable to long term fixed rate loans only.

### 3.3.1c. Insurance costs

The costs of insurance has been derived from the profit and loss statement (alternatively: revenue statement, profit and loss account, operating statement etc.) of inland waterway transport operators. It appears that insurance premiums depend on the insured value and carrying capacity of ships. The costs we use for our calculations are based on the amount paid for a ship in 2018. Other (non-vehicle) insurance costs have been grouped under general operating costs (section 3.3.5). Figures for the development of insurance costs stem from insurance companies, but have been acquired through inland waterway transport operators.

### 3.3.1d. Maintenance and repairs

Total annual costs of maintenance and repairs have been estimated per ship type, based on load capacity, time in use, cargo (i.e. which commodity group) and area of operation. The formula is based on profit and loss statements, and lies integrated in the Panteia cost model. 50% of the maintenance and repair costs are considered fixed; the other 50% is considered variable. This division is based on the causes of maintenance and repairs, as these can be either related or unrelated to the usage of the vehicle. Cost development for maintenance and repairs has been derived from the annual study Cost Development for Inland Waterway Transport and Forecast. The costs for maintenance and repairs are determined by means of an (annual) survey among inland waterway transport operators.

## **3.3.2. Variable costs**

We discern two subcategories of variable costs: fuel costs (a) and maintenance and repairs (b).



### 3.3.2a. Fuel costs

A ship's fuel consumption depends on multiple variables, the most important of which are: cruising speed, shape, dimensions, engine fuel consumption, load factor and engine power of the ship and dimensions and currents of the waterway. To determine average fuel usage per ship type, we have consulted our database of inland waterway transport itineraries, which includes all mentioned variables.

Inland waterway vessels almost exclusively run on gas oil. The fuel price fluctuates based on the supply and demand for both crude oil and gas oil. In the Netherlands, there is no excise tax on gas oil fuel, which leads to more dramatic price fluctuations than for other transport modes. To account for these fluctuations, we have opted to use the yearly average price for our calculations. The yearly average price of fuel in 2018 was €66,34 per 100 liters. This includes the mandatory waste charge as determined by the CDNI treaty (1996). It is important to note inland waterway transport operators receive an average fuel discount of 30% of the retail price. When consulting multiple inland waterway transport operators, they denoted this discount percentage as common and accepted practice.

Fuel cost development has been derived from the *Brandstofcirculaire* (Fuel flyer, previously known as Gas oil flyer) that is periodically published by CBRB. The discount mentioned above has been taken into account here as well.

### 3.3.2b. Maintenance and repairs

50% of the total annual maintenance and repairs is considered variable cost. See section 3.3.1d. When calculating the variable cost per hour, the maintenance and repairs cost should first be divided by 2 as well (the other half is part of the fixed costs).

### **3.3.3. Staff costs**

Those employed in inland waterway transport fall into two categories: paid employees working for companies and self-employed independent contractors. The latter group is relatively large within this transport mode. Independent contractors generally function as entrepreneur and employee of a small family business, which owns the single ship it operates. Oftentimes, independent skippers live on the ships with their families. The profusion of self-employment and family companies complicates the acquisition of wage data. Therefore, we opted to calculate labour costs based on current crew labour legislations Rijksoverheid (2020) and the CLA (Collective Labour Agreement). The current CLA stems from 2013, and for the time being there will not be a newer iteration as the degree of organization between employers is rather low. However, the *Centraal Bureau voor de Rijn- & Binnenvaart* (Central Bureau for Inland and Rhine Shipping; CBRB) publishes an updated wage table every six months, adjusted for rising price levels. In practice, staff costs will be slightly higher due to labour shortages. Still, we chose to base our calculations on the wage tables by CBRB (2020). This is to prevent that future reports, that also utilise price index numbers for wage increases, increase these figures by disproportionate amounts.

Staff costs for inland waterway transport are defined as follows: the total amount required by a business to have labour performed by salaried employees. Staff costs consist of gross wages, social (security) charges, pension contributions and supplements that apply to all personnel. The Inland waterway transport Regulation defines several vessel categories and modes of exploitation, namely:

- Vessel categories:
  - Motorized freight transport ships
  - Motorized tank transport ships
  - Push barge configurations



- Modes of exploitation:
  - Solo-navigation
  - Day navigation
  - Semi-continuous navigation
  - Continuous navigation

It is important to note these categories and modes of exploitation for two reasons. Firstly, because gross wages for various crew members (captain, skipper, sailor etc.) differ per vessel category. Secondly, because the crew regulations differ per vessel category and mode of exploitation, meaning that the minimum crew complement and crew configuration is different based on vessel category and ship type. For additional information on mode of exploitation, see paragraph 3.4.

To define the employers' gross expenses per employee and/or crew member, we utilised Panteia's labour cost model (*loonkostenberekeningsmodel*). This model was drawn up as part of Panteia (2017). This model can be used to calculate employers' total expenses per employee and/or crew members on a yearly basis, based on the gross wage, overtime- and vacation supplements, social (security) charges and pension schemes that were in force in 2018. These calculations were performed on all possible configurations of crew members for all three vessel categories. These calculations assumed minimum staffing levels per ship and per mode of exploitation allowed by the Inland Waterway transport Regulation. The size and configuration of crews for inland waterway freight transport vessels depends on the following factors:

- Total length of the vessel, which places it in one of the following categories:
  - ≤70 m
  - 70-86m
  - >86m
- Mode of exploitation:
  - Solo-navigation: one skipper, for a maximum of 2496 hrs/yr.
  - Day navigation (A1): for a maximum of 14 hrs/day between 06.00 and 22.00.
  - Semi-continuous navigation (A2): for a maximum of 18 hrs/day between 05.00 and 23.00.
  - Continuous navigation (B): up to 24 hrs/day.
- Type of equipment loadout:
  - Standard (S1)
  - Standard (S2): S1 equipment load + bow thrusters and electrical or hydraulic coupling winches.
- Specific for push barge configurations:
  - Dimensions of the configuration.
  - Composition:
    - A push-tug with one, two, three or four push barges
    - A standard inland waterway transport vessel with one, two or three push barges

To find the minimum crewing requirements for each type of ship by consulting figures E.1 and E.2 (appendix E) For instance: a ship ≤70 m using mode of exploitation A1 (day navigation) and using a S1 (standard) equipment loadout requires a single skipper and a single sailor.

#### **3.3.4. Mode-specific costs**

The sole cost type in this category is port dues. Panteia has a database containing several hundred thousand inland waterway transport itineraries. Based on load capacity, commodity group of cargo, travel profile, fees in the ports of loading and unloading and maximum amount of itineraries per ship per year, we have calculated annual port due averages for every vessel type. Cost development



of mode-specific costs have been derived from annual port due mutations for the ports of Rotterdam and Amsterdam.

### 3.3.5. General operating costs

This final category contains all miscellaneous costs that do not belong in the other four categories. Only permits and certification requires further detailing. Cost development of this final category has been determined using the customer price index numbers that are annually published by CBS.

#### 3.3.5a. Permits and certification

Entrepreneurs and vessel crews require multiple permits and certification based on time and area of operation, vessel size etc. In the Netherlands, *KiWa NV* (alternatively: KiWa Register) issues permits and certificates for a fee. These include:

- Proof of Professional Competence, required for operating a ship with a capacity of  $\geq 200t$  or a volume of  $\geq 100m^3$
- Historical supporting document of Proof of Professional Competence
- Exemption of Proof of Professional Competence
- Certified copy of Proof of Professional Competence
- Rhine navigation declaration
- Certified copy of the Rhine navigation declaration
- Exemption of fixed shipping hours or minimum crew requirements
- Proof of admission to transport on Dutch inland waterways

#### 3.3.5b. Other general operating costs

- Real estate
- IT, automation and communication
- Overhead
- Administration
- Non-vehicle and miscellaneous insurance
- Non-vehicle and miscellaneous asset depreciations or leases

### 3.3.6. Information sources

- Organization: Rijksoverheid  
Title (NL): Binnenvaartregeling  
Title (EN): Inland waterway transport Regulation  
Year: 2020  
Reference / link: <https://wetten.overheid.nl/BWBR0025958/2020-01-01>
- Organization: Centraal Bureau voor de Rijn- en Binnenvaart  
Title (NL): Loontabel 1 januari 2020  
Title (EN): *Wage table 1 January 2020*  
Year: 2020  
Reference / link: <https://www.cbrb.nl/publicaties/35-informatie-voor-werkgevers/1374-loontabel-1-januari-2020>



- Organization: Panteia  
Title (NL): Kostenontwikkeling (jaar) Binnenvaart en Raming (jaar)  
Title (EN): Cost Development for Inland Waterway Transport (year) and Forecast (year)  
Year: Annual  
Reference / link: <https://www.panteia.nl/nieuws/stijging-kosten-binnenvaart-zet-door-2018/>
- Organization: Centraal Bureau voor de Rijn- en Binnenvaart  
Title (NL): CBRB-Brandstofcirculaire  
Title (EN): CBRB Fuel flyer  
Year: n/a  
Reference / link: <https://www.cbrb.nl/publicaties/44-vervoervoorwaarden/256-abonnement-cbrb-brandstofcirculaire>
- Organization: Centraal Bureau voor de Rijn- en Binnenvaart  
Title (NL): Gasolieprijs CBRB  
Title (EN): Gas oil pricing CBRB  
Year: 2014-2019  
Reference / link: <https://www.zandmij.nl/logistiek/cbrb>
- Organization: CDNI  
Title (NL): Verdrag  
Title (EN): Treaty  
Year: 1996  
Reference / link: <https://www.cdni-iwt.org/presentatie-van-het-cdni/?lang=nl>
- Organization: CBS  
Title (NL): Consumentenprijzen prijsindex  
Title (EN): Consumer prices index  
Year: n/a  
Reference / link: <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83131NED/table?ts=1585819490737>

### 3.4 Mode-specific methodological remarks

Cost calculations for inland waterway transport often distinguish between the three main markets, or areas of operation, in the Netherlands. The main markets are:

- Rhine shipping (to/from Germany and beyond)
- Domestic shipping and transport to Belgium
- North-south shipping (to/from France)

For this analysis and calculating CFFT, the three areas have been regarded as a whole. We utilised the average of the three, weighted for volume. The areas of operation only affect fuel costs, due to different currents for each area. For example, the Rhine has a strong upstream current, which leads to increased fuel usage.

**Note that the cost calculations are based solely on Dutch vessels in use by companies based in the Netherlands.** Foreign fleets have not been taken into account, even if they operate on Dutch inland waterways. However, the CFFT for the inland waterway transport mode can be considered representative for the cost of inland waterway transport in the entire Western-European market for three reasons. Firstly, the cost composition of inland waterway transport does not vary significantly in this region. Secondly, the Dutch inland waterway fleet controls approximately 50-60% of the total



market. Thirdly, a large part of the Dutch inland waterway fleet's transport performance (tonkm) is accumulated abroad.

For inland waterway transport, several modes of exploitation have been determined, that are crucial for determining costs per hour. This is because these modes of exploitation prescribe the average time in use on an annual basis. The modes of exploitation and average annual times in use are:

- Solo-navigation (alleenvaart): 2.496 hr/yr
- Day travel (A1): 3.360 hr/yr
- Semi-continuous navigation (A2): 4.752 hr/ yr
- (Fully) continuous navigation (B): 8.064 hr/yr

Which mode of exploitation is used directly affects staff costs, as well as the costs per hour and costs per kilometre (total costs divided by time in use and/or distance travelled). For this analysis, we have opted to determine a weighted average of exploitation based on our database, which provides us with the average annual time in use for all modes of exploitation. Generally, smaller vessels are used for solo-navigation whereas larger ones are used fully continuously. This means that a solo-navigation mode of exploitation for a Rijnmax ship (6.000 tonnes) of capacity is theoretically possible, but practically unfeasible. More details on modes of exploitation can be found in section 3.3.3.

### **3.5 Cost Figures (2018)**

The tables below show the CFFT for the inland waterway transport mode for 2018. CFFT are provided for each of the four ship types and each of the four types of cargo. Tables that show the CFFT for each viable combination of ship type and commodity group (as set out in figure 3.1) can be found in appendix A.



Table 3.3. Cost figures in euros (€) per type of cargo for small ships and push barges for 2018.

	<b>Small ships</b>			<b>Push barges</b>
<b>Absolute costs</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Container</b>	<b>Dry bulk</b>
Fixed costs	20.892	20.520	29.260	1.035.993
Variable costs	24.381	24.252	27.424	1.707.629
Staff costs	104.684	107.953	107.953	689.973
Mode-specific costs	4.273	4.465	7.987	95.858
General operating costs	8.300	8.300	8.300	189.817
Total annual costs	162.530	165.491	180.924	3.719.270
<b>Costs per kilometre</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Container</b>	<b>Dry bulk</b>
Fixed costs	1,02	1,02	1,22	9,35
Variable costs	1,20	1,21	1,15	15,42
Staff costs	5,13	5,37	4,51	6,23
Mode-specific costs	0,21	0,22	0,33	0,87
General operating costs	0,41	0,41	0,35	1,71
Total costs per km	7,97	8,23	7,56	33,58
<b>Costs per hour</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Container</b>	<b>Dry bulk</b>
Fixed costs	5,55	5,36	7,64	128,47
Variable costs	6,47	6,33	7,16	211,76
Staff costs	27,79	28,19	28,19	85,56
Mode-specific costs	1,13	1,17	2,09	11,89
General operating costs	2,20	2,17	2,17	23,54
Total costs per hour	43,14	43,21	47,24	461,22
<b>Costs per tonne-kilometre</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Container</b>	<b>Dry bulk</b>
Fixed costs	0,004	0,005	0,013	0,002
Variable costs	0,005	0,006	0,050	0,004
Staff costs	0,021	0,026	0,004	0,002
Mode-specific costs	0,001	0,001	0,004	0,000
General operating costs	0,002	0,002	0,084	0,000
Total costs per tonkm	0,033	0,040	0,013	0,009
<b>Costs per tonne per hour</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Container</b>	<b>Dry bulk</b>
Fixed costs	0,023	0,026	0,085	0,034
Variable costs	0,027	0,030	0,080	0,057
Staff costs	0,114	0,136	0,315	0,023
Mode-specific costs	0,005	0,006	0,023	0,003
General operating costs	0,009	0,010	0,024	0,006
Total costs per tonne per hour	0,177	0,208	0,528	0,123
<b>(Un)loading and waiting</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Container</b>	<b>Dry bulk</b>
Loading: costs per hour	35,53	35,71	37,99	237,57
Unloading: costs per hour	35,53	35,71	37,99	237,57
Waiting: cost per hour	35,53	35,71	37,99	237,57



Table 3.4. Cost figures in euros (€) per type of cargo for medium ships for 2018.

<b>Absolute costs</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	66.901	213.043	66.284	102.287
Variable costs	59.731	61.834	58.570	69.300
Staff costs	140.871	155.543	140.453	183.584
Mode-specific costs	9.788	9.581	9.406	14.071
General operating costs	12.180	12.180	12.180	12.180
Total annual costs	289.471	452.180	286.893	381.421
<b>Costs per kilometre</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	2,62	7,96	2,63	3,01
Variable costs	2,34	2,31	2,33	2,04
Staff costs	5,52	5,81	5,58	5,40
Mode-specific costs	0,38	0,36	0,37	0,41
General operating costs	0,48	0,45	0,48	0,36
Total costs per km	11,35	16,89	11,39	11,22
<b>Costs per hour</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	16,82	52,54	16,69	21,86
Variable costs	15,02	15,25	14,75	14,81
Staff costs	35,41	38,36	35,37	39,24
Mode-specific costs	2,46	2,36	2,37	3,01
General operating costs	3,06	3,00	3,07	2,60
Total costs per hour	72,77	111,51	72,25	81,52
<b>Costs per tonne-kilometre</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,005	0,018	0,006	0,009
Variable costs	0,004	0,005	0,005	0,006
Staff costs	0,009	0,013	0,012	0,016
Mode-specific costs	0,001	0,001	0,001	0,001
General operating costs	0,001	0,001	0,001	0,001
Total costs per tonkm	0,020	0,037	0,024	0,033
<b>Costs per tonne per hour</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,029	0,116	0,035	0,064
Variable costs	0,026	0,034	0,031	0,044
Staff costs	0,061	0,085	0,075	0,116
Mode-specific costs	0,004	0,005	0,005	0,009
General operating costs	0,005	0,007	0,006	0,008
Total costs per tonne per hour	0,125	0,246	0,153	0,240
<b>(Un)loading and waiting</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Loading: costs per hour	55,29	93,90	55,13	63,70
Unloading: costs per hour	55,29	93,90	55,13	63,70
Waiting: cost per hour	55,29	93,90	55,13	63,70



Table 3.5. Cost figures in euros (€) per type of cargo for large ships for 2018.

<b>Absolute costs</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	202.747	460.530	200.804	251.918
Variable costs	116.417	147.346	114.086	166.368
Staff costs	191.618	371.740	191.048	403.644
Mode-specific costs	15.380	19.352	14.780	30.707
General operating costs	18.519	18.519	18.519	18.519
Total annual costs	544.681	1.017.487	539.237	871.157
<b>Costs per kilometre</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	6,13	9,90	6,20	4,98
Variable costs	3,52	3,17	3,52	3,29
Staff costs	5,79	7,99	5,89	7,98
Mode-specific costs	0,46	0,42	0,46	0,61
General operating costs	0,56	0,40	0,57	0,37
Total costs per km	16,47	21,88	16,64	17,23
<b>Costs per hour</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	46,87	73,99	46,50	36,92
Variable costs	26,91	23,67	26,42	24,38
Staff costs	44,30	59,73	44,24	59,16
Mode-specific costs	3,56	3,11	3,42	4,50
General operating costs	4,28	2,98	4,29	2,71
Total costs per hour	125,92	163,48	124,88	127,68
<b>Costs per tonne-kilometre</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,006	0,012	0,008	0,007
Variable costs	0,004	0,004	0,004	0,004
Staff costs	0,006	0,010	0,007	0,011
Mode-specific costs	0,000	0,001	0,001	0,001
General operating costs	0,001	0,000	0,001	0,000
Total costs per tonkm	0,017	0,027	0,020	0,023
<b>Costs per tonne per hour</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,049	0,093	0,057	0,050
Variable costs	0,028	0,030	0,032	0,033
Staff costs	0,046	0,075	0,054	0,079
Mode-specific costs	0,004	0,004	0,004	0,006
General operating costs	0,004	0,004	0,005	0,004
Total costs per tonne per hour	0,132	0,204	0,153	0,171
<b>(Un)loading and waiting</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Loading: costs per hour	95,45	136,69	95,04	98,80
Unloading: costs per hour	95,45	136,69	95,04	98,80
Waiting: cost per hour	95,45	136,69	95,04	98,80



### 3.6 Cost development (2016-2018)

The table below shows the cost development for 2016-2018, in the form of percentage-based changes relative to the year before. These percentages are based on annual average costs for both years.

Table 3.6. Cost development percentages for the inland waterway mode.

	2016/2017	2017/2018
<b>Fixed costs</b>		
Depreciations	1,50%	1,50%
Insurance	1,70%	1,50%
Interest	9,05%	2,25%
Maintenance and repairs	2,50%	3,50%
<b>Variable costs</b>		
Maintenance and repairs	2,50%	3,50%
Fuel	14,48%	16,31%
<b>Staff costs</b>	2,00%	2,30%
<b>Mode-specific costs</b>	0,30%	1,00%
<b>General operating costs</b>	1,60%	1,60%



## 4. Road transport

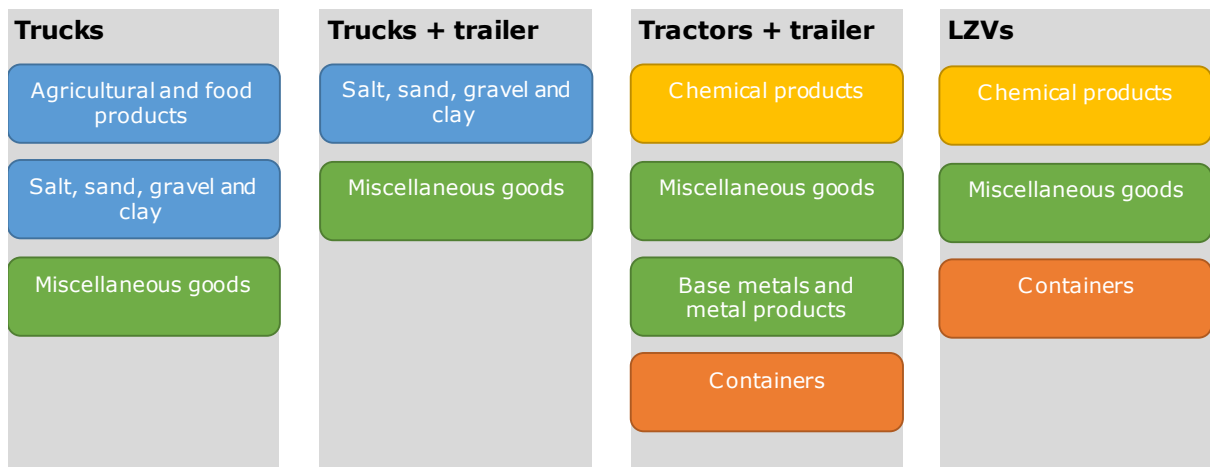
### 4.1 Introduction and general information

Road transport signifies transport with freight vehicles between hubs, terminals, warehouses, stores and other locations. Freight vehicles include trucks, tractor-trailer combinations and delivery vans. The Dutch road network is very dense, and includes a large number of highways, especially in the western half of the country.

#### 4.1.1. Standard vehicles

A large number of vehicle sizes and combinations exist, but for the purpose of this analysis we have selected four main types: trucks, truck + trailer, tractor + trailer and LZV. LZV is short for *Langere Zwaardere Vrachtautocombinatie*, which translates to 'longer and heavier truck configuration'. An LZV, alternatively called an *ecocombi*, is essentially a standard truck with an extra trailer. As the name suggests, the maximum weights and lengths for LZVs are higher than those of regular trucks. The *Wegenverkeerswet* (Dutch Law on Road Traffic) allows for LZVs to operate on the entire main road network of the Netherlands, but internationally they are only allowed in parts of western Germany and northern Belgium. Figure 4.1 provides an overview of which of the goods are transported in practice with each type of vehicle.

Figure 4.3 The four types of vehicles analysed for the road transport mode and the commodity groups they transport. The colour scheme follows the same principle as in figure 2.1: blue signifies dry bulk, yellow signifies Liquid bulk, green signifies break bulk and orange signifies containerized cargo.



Source: Panteia

#### 4.1.2. Specialized vehicles

Besides the four main vehicle types, three other types have been analysed: delivery vans, solo tractors (without trailer) and specialized transport vehicles. All of these vehicles are only used for a single type of transport. Delivery vans are used to transport packages, parcels and related from distribution centres to homes. The number of home deliveries has seen an explosion in the past decade due to the rise of e-commerce. In terms of freight volume, however, e-commerce-related deliveries only make up a small part of total road transport in the Netherlands. Finally, special transport refers to a collection of vehicles with highly specific functions that are classified as such by Statistics Netherlands (CBS). The category 'special vehicles' includes automotive transport vehicles, garbage trucks, mobile cranes, fire trucks, campers et cetera. We have adapted the CBS



data to extract data for the only two types of special vehicle that actually perform freight transport. Therefore, special vehicles in this analysis only signifies car transport vehicles (a combination of a standard tractor and a specialised automotive trailer) and waste disposal vehicles.

## 4.2 Assumptions

This paragraph presents an exhaustive overview of the assumptions we used to calculate the CFFT for the road transport mode. The information sources utilised are listed in section 4.2.2.

### 4.2.1. Non-cost data

To acquire a complete dataset required for calculating CFFT for the road transport mode, the information in figure 4.1 was combined with the 2018 data on average tonnage, average time in use and distance travelled for the four standard vehicle types. Panteia regularly gathers data concerning which vehicles are used in practice to transport each applicable commodity group, as well as average tonnages, from a large number of Dutch road transport operators. This data serves as source material for the annual publication *Kostenontwikkeling in het wegvervoer* (Cost development in road transport). Figures on time in use and distance travelled are assumed as annual averages for deployment of vehicle types for transporting commodity groups. Figures for the utilisation rate have been taken from CE Delft and Panteia (2016). This data allowed for the composition of table 4.1 for every relevant combination of vehicle type and commodity group shown in figure 4.1.

Table 4.1. Data on the road transport mode.

Vehicle type	Commodity group	Average tonnage (tonne)	Time in use (hr/yr)	Distance travelled (km / yr)	Utilisation rate (%)
Truck (dump)	Agricultural and food products	5,4	2.400	55.000	42
Truck (dump)	Salt, sand, gravel and clay	8,3	2.400	50.000	42
Truck (box)	Miscellaneous goods	5,1	2.585	78.000	39
Truck + trailer	Salt, sand, gravel and clay	11,6	2.400	55.000	42
Truck + trailer	Miscellaneous goods	10,9	2.585	78.000	39
Tractor + trailer	Chemical products	13,9	2.640	110.000	48
Tractor + trailer	Miscellaneous goods	13,2	2.585	78.000	46
Tractor + trailer	Base metals and metal products	13,9	2.585	90.000	48
Tractor + trailer	Containers	13,2	2.585	105.000	46
LZV	Chemical products	19,7	2.690	110.000	48
LZV	Miscellaneous goods	18,7	2.640	78.000	46
LZV	Containers	18,7	2.690	105.000	46
Delivery van	n/a	0,2	2.585	60.000	21
Tractor solo	n/a	n/a	2.585	78.000	n/a
Special vehicle	n/a	n/a	2.468	55.250	n/a

Source: Panteia (2018)

As stated above, the road transport mode contains four types of standard vehicle and three types of specialized vehicle. For this transport mode, specifications like maximum capacity or maximum dimensions are not determined by the vehicle type, but rather by national legislation. As such, maximum weight for trucks differs per country. Of the three dimensions, only the maximum length is relevant, as maximum width and height are fixed by EU legislation at respectively 2,55 and 4m (see European Commission 1996). The maximum width for temperature-controlled vehicles (using a reefer trailer) is slightly larger, at 2,60m. The data in table 4.2 is publicly available, and regularly



published by organizations such as *Rijksdienst voor het Wegverkeer* (National Service for Road Traffic; RDW).

Table 4.2. Vehicle types and specifications for the road transport mode in the Netherlands.

Vehicle type	Maximum length (m)	Maximum total weight (tonne)	Effective capacity (tonne)
Truck	16,50	50	13-20*
Truck + trailer	18,75	50	28
Tractor + trailer	16,50	50	29
LZV	25,50	60	29

Source: RDW (2012)

\* Maximum capacity depends on the commodity group here, as there are two variants of the regular truck: box trucks and dump trucks. The respective maximum weights are 13t and 20t.

#### 4.2.2. Information sources

- Organization:** Panteia  
**Title (NL):** Kostenontwikkelingen in het wegvervoer 2018-2019  
**Title (EN):** Cost development in road transport 2018-2019  
**Year:** 2018  
**Reference / link:** <https://www.panteia.nl/webshop/kostenontwikkelingen-in-het-wegvervoer-2019-2020/>
- Organization:** Rijkswaterstaat  
**Title (NL):** Kostenbarometer Goederenvervoer  
**Title (EN):** Cost gauge for Freight Transport  
**Year:** 2016  
**Reference / link:** <https://www.rwseconomie.nl/documenten/publicaties/2016/februari/kostenbarometer-en-binnenvaarttool/schaduwrijzen-milieubeleid>
- Organization:** European Commission  
**Title (NL):** Richtlijn 96/53/EG  
**Title (EN):** Council Directive 96/53/EC  
**Year:** 1996  
**Reference / link:** <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31996L0053&from=NL>
- Organization:** RDW  
**Title (NL):** Overzicht maten en gewichten in Nederlands  
**Title (EN):** Overview for weights and dimensions in the Netherlands  
**Year:** 2012  
**Reference / link:** <https://www.rdw.nl/-/media/rdw/rdw/pdf/sitecollectiondocuments/ontheffingen-tet/themasite-ontheffingen/handleidingen/2-b-1097b-overzicht-maten-en-gewichten.pdf>
- Organization:** CE Delft, Panteia  
**Title (NL):** STREAM Goederenvervoer 2016  
**Title (EN):** STREAM Freight Transport 2016  
**Year:** 2017  
**Reference / link:** [https://www.ce.nl/publicatie/stream\\_goederenvervoer\\_2016/1854](https://www.ce.nl/publicatie/stream_goederenvervoer_2016/1854)



## 4.3 Cost methodology

This paragraph presents an exhaustive overview of the methodology we used to determine the cost categories for this mode. The information sources utilised are listed in section 4.3.6. Several sources listed in section 4.2.2 were consulted again for this paragraph, but are not listed again in this paragraph. The division and grouping of cost (sub)categories for the road transport mode are based on Panteia's methodology developed for the annual Cost Development studies.

### 4.3.1. Fixed costs

The following list provides an overview of fixed cost components:

- Depreciations of capital assets (a)
- Vehicle Excise Duty (b)
- *Eurovignet* (c)
- Interest on capital assets (d)
- Insurance costs (e)
- Miscellaneous vehicle costs (f)
- Costs for auxiliary hauled assets (g)

#### 4.3.1a. Depreciations of capital assets

Depreciations on road transport vehicles are based on purchase price, residual value and expected lifetime of the asset. Depreciations of towing and self-contained units (trucks, tractors and vans) are based on mileage whereas depreciations of hauled assets (trailers) are based on years since acquisition. Therefore, only the latter are considered fixed costs and calculated based on purchase value, residual value and useful life (in years). As such, trucks and other self-contained vehicles do not have fixed depreciations. The following formula was used:

Depreciation per yr = (replacement value – tyres – residual value) / economic life in yrs

Cost development of depreciations for road transport operators have been calculated based on annually collected data.

#### 4.3.1b. Motorised vehicles tax

*Motorrijtuigenbelasting* (Dutch tax on motorised vehicles; MRB) is an annual form of tax levied on most types of motorised vehicles that utilise public roads. Figures within this cost subcategory are based on the rates of the Dutch Tax and Customs Administration (*Belastingdienst*). The amount is annually adjusted for inflation. We have consulted *Belastingdienst* (2018) for the amount for 2018.

#### 4.3.1c. Eurovignet

The *eurovignet* is a requisite for utilizing trucks heavier than 12 tonnes on highways in the Netherlands, Luxemburg, Denmark and Sweden. The vignette also acts as proof of payment of specialised taxes for heavy goods vehicles in the Netherlands (*belasting zware motorrijtuigen*; BZW), and is regarded as form of road toll. Figures within this cost subcategory are based on the rates of the *Belastingdienst*. The price for the *eurovignet* depends on the emission level of the vehicle within the European emission standard and the number of axles. The price for vehicles within the euro 5 and 6 levels in 2016-2018 was €750 for 1-3 axles and €1250 for 4 or more axles. Note that the *eurovignet* acts as a toll for a certain period, rather than a pay-per-kilometre toll. The validity period for the *eurovignet* lasts up to a year.

#### 4.3.1d. Interest costs

Road transport operators incur interest cost upon purchasing vehicles. This can occur in several ways. For instance, it is general practice to take out bank loans to acquire capital for the purchase of trucks. Additionally, if a transport operator invests his capital in vehicles, it means that this



capital cannot be invested in other means and the operator loses out on interest income. Interest on the average invested capital per year have been calculated using the following formula:

$$\text{Annual interest cost} = \% \text{ interest} * (\text{depreciated replacement cost} + \text{residual value}) / 2$$

Cost development of interest costs for road transport operators have been calculated based on annually collected data.

#### 4.3.1e. Insurance costs

This subcategory only covers the costs of vehicle insurance. Insurance on other assets is grouped under general operating costs. Data on absolute actual insurance costs are collected each year from road transport operators. We used data provided to us by several (transport) insurance companies to determine the insurance percentages, and track their development.

#### 4.3.1f. Miscellaneous vehicle costs

This is a residual category for small fixed expenses directly related to the vehicles. If not directly related, miscellaneous costs are included in general operating costs. This subcategory includes truck tarpaulins, smaller materiel and related. Both actual costs and cost development are based on data collected from road freight transport operators.

#### 4.3.1g. Cost reserve for auxiliary hauled assets

Transport operators need to periodically make arrangements for extra trailers and other hauled stock, which incurs costs. Arrangements include owning spares and temporary renting. There exist several reasons for this, like accidents, but the most important one is obligatory periodical inspections. Note that this cost subcategory is not deliberately budgeted by transport operators, nor included in bookkeeping (generally). However, it is a relevant tool for determining CFFT and can be calculated consistently. Simply put, this subcategory contains the costs for not directly utilising hauled stock when there is a discrepancy between towing and hauled assets. Both actual costs and cost development are based on data collected from road freight transport operators.

### **4.3.2. Variable costs**

The following subcategories make up the variable cost category: fuel costs (a), depreciations of capital assets (b), tyres (c), and maintenance and repairs (d).

#### 4.3.2a. Fuel costs

The height and development of fuel costs are determined by the Dutch diesel price. **An average of 2018 has been calculated based on data for that year. The average price for a litre of automobile diesel in the Netherlands in 2018 was €1,18 (118,61 cents).** Average diesel prices for 2016 and 2017 were used to calculate cost development. Excise duty on diesel in the Netherlands was €0,48981 per litre in 2018, €0,48592 in 2017 and €0,48447 per litre in 2016. Diesel prices were found by consulting Evofenedex (2019).

#### 4.3.2b. Depreciations of capital assets

As stated above, only the depreciation of trucks and tractors are considered variable costs, as these are based on distance travelled. The average depreciation per kilometre are based on the following formula:

$$\text{Depreciation per km} = (\text{replacement value} - \text{tyres} - \text{residual value}) / \text{useful life in km}$$

Both absolute costs and cost development are based on data collected from road freight transport operators.



#### 4.3.2c. Tyres

The costs in this subcategory are collected annually from road transport operators. During these interviews, data on the duration of the economic life of tyres was also gathered for different types of tractor units and trailers. This data was used to determine the average economic life, although it should be noted that economic life also varies per commodity group. We have determined cost development by tracking the suggested retail price for HGV tyres at several tyre retail companies.

#### 4.3.2d. Maintenance and repairs

Absolute cost figures for maintenance and repair have been collected from road transport operators. Maintenance and repairs costs are fully variable in road transport, rather than being divided between the fixed and variable categories. The reason is that costs for maintenance and repair in this transport mode are wholly dependent on the wages of mechanics, the cost of spare vehicle parts and repair rates by third parties. In this calculation, the wage rates for mechanics are based on index numbers for wage trends. Price rates and development for spare vehicle parts have been collected from CBS 2018 (Statistics Netherlands). Rates for repairs by third parties have been determined based on the conditions of Bovag (Dutch trade association for dealerships and garages) for each year.

### **4.3.3. Staff costs**

Staff costs in road freight transport consist of three subcategories: wages including social charges (a) are the largest, whereas accommodation costs (b) and miscellaneous staff costs (c) make up small parts. This category only applies to drivers, as costs for other personnel are included in section 4.3.5. Actual costs and are based on data collected from road freight transport operators. Cost development is based on the mutations of wages et cetera listed in the Collective Labour Agreement.

#### 4.3.3a. Wages including social charges

Wages and social charges are derived from the Collective Labour Agreement for the road transport sector. Both employers and employees in this sector have relatively high grades of organisation, meaning that the CLA 2017-2019 is generally binding for all companies and workers in the mode.

#### 4.3.3b. Accommodation costs

Accommodation costs are derived from the CLA for road transport, which prescribes the amount to be compensated to drivers in different situations. The multitude of variants and different amounts have been established by the *Belastingdienst*.

#### 4.3.3c. Miscellaneous staff costs

This is a residual category for small expenses related to drivers.

### **4.3.4. Mode-specific costs**

Several cost subcategories fall under this category that do not require further elaboration. These are: cargo insurance, costs arising from cargo damage or theft, inspections, permits and certification. The most ubiquitously required permit here is the Euro license – not to be confused with the *europignet*. The former is issued by the *Nationale en Internationale Wegvervoer Organisatie* (National and International Road Freight Transport Organisation; NIWO) and the latter by the National Tax and Customs Service. The cost development of mode-specific costs have been derived from periodic listings CBS, based on index numbers.



#### 4.3.5. General operating costs

This final category contains all costs that do not belong in the other four categories. Costs in this category are related to the operation of a business, and are as such not specific to (road) transport. This category consists of:

- Wages including social charges for non-driver staff
- Real estate
- Administration, IT, automation, communication
- Miscellaneous general costs

Wage development for non-driver staff is based on the CLA for road transport, which also includes pay rates for other personnel. Cost development for the others have been calculated based on annually collected cost data from road freight operators.

#### 4.3.6. Information sources

- Organization: Panteia  
Title (NL): Kostencalculaties in het beroepsgoederenvervoer over de weg: Prijsspeil 1-7-2018  
Title (EN): Cost calculations for road freight transport: Price level 1-7-2018  
Year: 2018  
Reference / link:  
[https://www.panteia.nl/index.cfm/\\_api/render/file/?method=inline&fileID=5B52D01F-D3BA-4170-9179D3CC1C0706B5](https://www.panteia.nl/index.cfm/_api/render/file/?method=inline&fileID=5B52D01F-D3BA-4170-9179D3CC1C0706B5)
- Organization: Belastingdienst  
Title (NL): Belastingen op auto en motor  
Title (EN): Tax rates on cars and motorcycles  
Year: 2018  
Reference / link:  
[https://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/prive/auto\\_en\\_vervoer/belastingen\\_op\\_auto\\_en\\_motor/](https://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/prive/auto_en_vervoer/belastingen_op_auto_en_motor/)
- Organization: TLN, CNV, FNV, De Unie  
Title (NL): CAO Beroepsgoederenvervoer over de weg en de verhuur van mobiele kranen: 1 januari 2017 t/m 31 december 2019  
Title (EN): CLA Road freight transport and rental of mobile cranes: 01-01-2017 to 31-12-2019  
Year: 2016  
Reference / link: <https://www.fnv.nl/getmedia/9cc5fc95-9b7a-4936-94ed-94bc7775e3bc/498-Beroepsgoederenvervoer-cao-2017-2019-v301118.pdf?ext=.pdf&dttime=20190516120025>
- Organization: Evofenedex  
Title (NL): Dossier Dieselprijs  
Title (EN): Dossier on Diesel pricing  
Year: 2019  
Reference / link: <https://www.evofenedex.nl/kennis/vervoer/dieselprijs>



- Organization: CBS  
Title (NL): Producentenprijzen (PPI); afzet-, invoer-, verbruiksprijzen, index 2015=100: Andere delen en toebehoren van auto's  
Title (EN): Producer prices (PPI); sales, import, consumption prices, index 2015=100: Miscellaneous parts and automotive  
Year: 2018  
Reference / link:  
<https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83935NED/table?ts=1583328735535>

#### **4.4 Mode-specific methodological remarks**

Information in this chapter has been nearly completely derived from cost figures for road transport present at Panteia. Several hundred road transport companies are visited regularly to collect this data. This is part of an annual investigation commissioned by NIWO.

#### **4.5 Cost Figures (2018)**

The CFFT for road transport for 2018 are presented in the following tables.



Table 4.3. Cost figures per type of cargo for trucks and truck + trailers. Figures are in euros (€) for 2018.

	<b>Trucks</b>		<b>Truck + trailers</b>	
<b>Absolute costs</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Dry bulk</b>	<b>Break bulk</b>
Fixed costs	7.999	7.695	16.548	14.732
Variable costs	42.659	39.284	41.510	51.500
Staff costs	62.706	71.210	66.714	71.210
Mode-specific costs	373	373	1.242	930
General operating costs	18.241	19.003	20.199	22.192
Total annual costs	131.978	137.566	146.214	160.565
<b>Costs per kilometre</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Dry bulk</b>	<b>Break bulk</b>
Fixed costs	0,15	0,10	0,30	0,19
Variable costs	0,81	0,50	0,75	0,66
Staff costs	1,19	0,91	1,21	0,91
Mode-specific costs	0,01	0,00	0,02	0,01
General operating costs	0,35	0,24	0,37	0,28
Total costs per km	2,51	1,76	2,66	2,06
<b>Costs per hour</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Dry bulk</b>	<b>Break bulk</b>
Fixed costs	3,33	2,98	6,90	5,70
Variable costs	17,77	15,20	17,30	19,92
Staff costs	26,13	27,55	27,80	27,55
Mode-specific costs	0,16	0,14	0,52	0,36
General operating costs	7,60	7,35	8,42	8,58
Total costs per hour	54,99	53,22	60,92	62,11
<b>Costs per tonne-kilometre</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Dry bulk</b>	<b>Break bulk</b>
Fixed costs	0,022	0,019	0,026	0,017
Variable costs	0,118	0,099	0,065	0,060
Staff costs	0,174	0,180	0,104	0,084
Mode-specific costs	0,001	0,001	0,002	0,001
General operating costs	0,051	0,048	0,032	0,026
Total costs per tonkm	0,366	0,348	0,228	0,189
<b>Costs per tonne per hour</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Dry bulk</b>	<b>Break bulk</b>
Fixed costs	0,49	0,59	0,59	0,52
Variable costs	2,59	3,00	1,48	1,82
Staff costs	3,81	5,43	2,39	2,52
Mode-specific costs	0,02	0,03	0,04	0,03
General operating costs	1,11	1,45	0,72	0,79
Total costs per tonne per hour	8,01	10,50	5,23	5,69
<b>(Un)loading and waiting</b>	<b>Dry bulk</b>	<b>Break bulk</b>	<b>Dry bulk</b>	<b>Break bulk</b>
Loading: costs per hour	37,06	37,88	43,11	41,83
Unloading: costs per hour	37,06	37,88	43,11	41,83
Waiting: cost per hour	37,06	37,88	43,11	41,83



Table 4.4. Cost figures per type of cargo for tractor + trailers. Figures are in euros (€) for 2018.

<b>Absolute costs</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	23.759	15.446	12.878
Variable costs	70.898	51.846	59.806
Staff costs	72.725	71.210	71.210
Mode-specific costs	1.368	930	932
General operating costs	26.235	22.366	14.967
Total annual costs	194.986	161.797	159.794
<b>Costs per kilometre</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,22	0,18	0,12
Variable costs	0,64	0,62	0,57
Staff costs	0,66	0,85	0,68
Mode-specific costs	0,01	0,01	0,01
General operating costs	0,24	0,27	0,14
Total costs per km	1,77	1,93	1,52
<b>Costs per hour</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	9,00	5,98	4,98
Variable costs	26,86	20,06	23,14
Staff costs	27,55	27,55	27,55
Mode-specific costs	0,52	0,36	0,36
General operating costs	9,94	8,65	5,79
Total costs per hour	73,86	62,59	61,82
<b>Costs per tonne-kilometre</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,016	0,014	0,009
Variable costs	0,046	0,046	0,043
Staff costs	0,047	0,063	0,051
Mode-specific costs	0,001	0,001	0,001
General operating costs	0,017	0,020	0,011
Total costs per tonkm	0,127	0,142	0,115
<b>Costs per tonne per hour</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,65	0,44	0,38
Variable costs	1,93	1,48	1,75
Staff costs	1,98	2,03	2,09
Mode-specific costs	0,04	0,03	0,03
General operating costs	0,71	0,64	0,44
Total costs per tonne per hour	5,31	4,62	4,68
<b>(Un)loading and waiting</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Loading: costs per hour	46,48	42,17	38,32
Unloading: costs per hour	46,48	42,17	38,32
Waiting: cost per hour	46,48	42,17	38,32



Table 4.5. Cost figures per type of cargo for LZVs. Figures are in euros (€) for 2018.

<b>Absolute costs</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	34.000	17.753	14.806
Variable costs	73.679	55.230	70.330
Staff costs	74.103	72.725	74.103
Mode-specific costs	915	915	915
General operating costs	22.891	18.367	20.088
Total annual costs	205.588	164.990	180.242
<b>Costs per kilometre</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,31	0,23	0,14
Variable costs	0,67	0,71	0,67
Staff costs	0,67	0,93	0,71
Mode-specific costs	0,01	0,01	0,01
General operating costs	0,21	0,24	0,19
Total costs per km	1,87	2,12	1,72
<b>Costs per hour</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	12,64	6,72	5,50
Variable costs	27,39	20,92	26,15
Staff costs	27,55	27,55	27,55
Mode-specific costs	0,34	0,35	0,34
General operating costs	8,51	6,96	7,47
Total costs per hour	76,43	62,50	67,00
<b>Costs per tonne-kilometre</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,016	0,012	0,008
Variable costs	0,034	0,038	0,036
Staff costs	0,034	0,050	0,038
Mode-specific costs	0,000	0,001	0,000
General operating costs	0,011	0,013	0,010
Total costs per tonkm	0,095	0,113	0,092
<b>Costs per tonne per hour</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,64	0,36	0,30
Variable costs	1,39	1,12	1,40
Staff costs	1,40	1,48	1,48
Mode-specific costs	0,02	0,02	0,02
General operating costs	0,43	0,37	0,40
Total costs per tonne per hour	3,88	3,35	3,59
<b>(Un)loading and waiting</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Loading: costs per hour	48,70	41,23	40,52
Unloading: costs per hour	48,70	41,23	40,52
Waiting: cost per hour	48,70	41,23	40,52



## 4.6 Cost development (2016-2018)

The table below shows the cost development for 2016-2018, in the form of percentage-based changes relative to the year before. These percentages are based on annual average costs for both years.

Table 4.6. Cost development percentages for the road transport mode.

	2016/2017	2017/2018
<b>Fixed costs</b>		
Depreciations	0,6%	0,7%
MRB	0,3%	0,8%
<i>Eurovignet</i>	0,0%	0,0%
Interest	14,7%	3,9%
Insurance	10,8%	7,4%
Miscellaneous vehicle costs	1,4%	1,7%
Cost reserve aux. hauled assets	0,0%	0,0%
<b>Variable costs</b>		
Depreciations	0,6%	0,7%
Tyres	11,3%	-8,7%
Fuel	7,5%	9,0%
Maintenance and repairs	1,8%	2,6%
<b>Staff costs</b>		
Wages and social charges	1,3%	5,7%
Accommodation costs	1,1%	2,5%
Miscellaneous staff costs	1,1%	2,5%
<b>Mode-specific costs</b>	1,4%	1,7%
<b>General operating costs</b>		
Wages for other staff	1,3%	5,7%
Real estate	1,4%	1,7%
Miscellaneous general costs	1,4%	1,7%



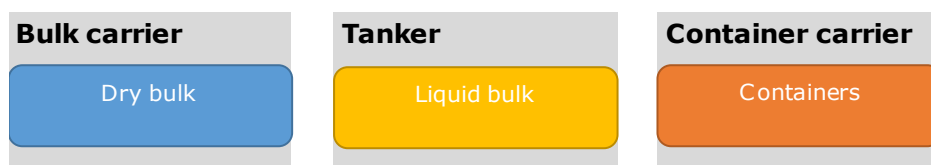
## 5. Maritime transport

### 5.1 Introduction and general information

Maritime transport signifies freight transport using seaborne ships between seaports, across seas and oceans. There are a number of seaports in the Netherlands, but the Port of Rotterdam is by far the largest, as well as being the busiest of Europe and eleventh busiest globally in 2018. The second largest harbour is the Port of Amsterdam. Dutch seaports are well-connected to other transport modes, predominantly inland waterway, railway and road transport.

A number of ship sizes and models are employed, but for the purpose of this study we have selected three vehicle types: bulk carriers, tankers and container carriers. The method utilised for this transport mode differs from those of the other modes. To summarize, the analysis of this transport mode does not follow the division of the ten commodity groups, but will only regard the types of cargo (see figure 2.1): dry bulk, liquid bulk and container. Break bulk is omitted from analysis due to a lack of data for this commodity group. Due to the international character, large size and relatively low number of maritime shipping companies, it was unfeasible to gather the data the same way as we have done for other transport modes. Fortunately, companies in the sector as well as related accountancy firms periodically publish cost and non-cost data in the form of cost development reports and other publications. Therefore, documentation in the sector is rather extensive, but simply different in format than that of the other transport modes. The nature of the data differs from other transport modes as well: distinctions are made based on the three vehicle types combined with the cargo types, rather than the ten commodity groups. The rationale and specific methodology used for this transport mode will be further explained in subsequent paragraphs.

Figure 5.4 The three types of vehicles analysed for the maritime transport mode and the cargo types they transport. Note that there is no data on the transport of the ten commodity groups. Below, simply all commodity groups that compose that type of cargo are listed. The colour scheme follows the same principle as in figure 2.1: blue signifies dry bulk, yellow signifies liquid bulk, green signifies break bulk and orange signifies containerized cargo.



Source: Panteia

Also note that the maritime transport operators studied for the calculation of CFFT for this transport mode are principally non-Dutch companies. Due to the large distances and global scale of operations, the companies are cosmopolitan in character. Most operators do have a terminal or office in Rotterdam, as it is the main shipping seaport of Europe. **Because we use averages from UNCTAD database, the analysis of maritime freight transport in this chapter includes both deep-sea and short-sea itineraries and ships.**

### 5.2 Assumptions

This paragraph presents an exhaustive overview of the assumptions we used to calculate the CFFT for the maritime transport mode. The information sources utilised are listed in section 5.2.2.



### 5.2.1. Non-cost data

For each of the three vehicle types, ten existent ships were randomly selected using the MarineTraffic database. Averages of the specifications were calculated, and used to construct one fictional average ship profile per vehicle type. These ship profiles have been utilised for calculating the CFFT. The specifications of each are presented in table 5.1.

Table 5.1. Specifications of the fictional average ship profile for the three vehicle types.

	Bulk carrier	Tanker	Container carrier
Average DWT* (tonne)	79.281	78.543	83.122
Average NT** (tonne)	46.856	48.195	74.736
NT / DWT ratio***	59,1%	61,3%	89,9%
Time in use (hr/yr)	8.280	8.280	8.280
Average speed (kn)	11	12	14
Average speed (km/h)	20,4	22,2	25,9
Utilisation rate	50%	34%	68%

Sources: Panteia, MarineTraffic, CE Delft and Panteia (2016)

\* DWT = deadweight tonnage. This is the total weight displacement capacity of a ship, or its maximum total weight. This includes the weight of fuel, supplies, ballast water etc. Figures for DWT are based on the assumption that ships are 0-4 years old.

\*\* NT = Net tonnage. This is effectively the maximum load a ship can carry, as it is based on the combined volume of all cargo spaces on board.

\*\*\* The percentage of a ship's maximum weight that can be devoted to carrying cargo.

Data for maximum capacity, deadweight and cruising speed have been derived from the MarineTraffic online database. Data on time in use has been derived from Panteia, TNO and Transcare (2004), and is based on the assumption that ships operate 345 days per year ( $345 * 24 = 8.280$  hrs). Figures for the utilisation rate have been calculated in CE Delft and Panteia (2016). These are well informed estimates based on data collection and observation.

The assumptions on vehicles in table 5.1 are insufficient to be able to calculate CFFT for the maritime mode, as there are no figures on distance (travelled) or navigation time. Therefore, it is necessary to select specific transport itineraries or routes as a basis of calculation. A representative itinerary for each of the three vehicle types has been selected. Note that these itineraries are also assumptions, but highly representative. Data for the routes is presented in table 5.2.



Table 5.2. Representative transport routes and their specifications.

	<b>Bulk carrier</b>	<b>Tanker</b>	<b>Container carrier</b>
Route	Porte de Madeira (BR) – Rotterdam (NL); 2 total	Congo (CG) – Rotterdam (NL); 2 total	Baltimore (US) – New York (US) – Rotterdam (NL) – Hamburg (DE) – Gdansk (PL) – Antwerp (BE) – Baltimore (US); 6 total
Total distance (NM)	4.108	4.791	9.177
Total distance (km)	7.608	8.873	16.996
Average speed (kn)*	11	12	14
Average speed (km/h)*	20,4	22,2	25,9
Navigation time (days)	15,6	16,6	27,3
Time anchored** (days)	1	1	3
Time (un)loading (days)	2,68	1,3	5,52
Total itinerary time (days)	19,28	18,9	35,82
Roundtrips per year	8,95	9,15	9,6
Total port calls per year	17,9	18,3	57,6
Distance travelled (km)	136.492	161.613	163.632

Sources: MarineTraffic, sea-distances.org, UNCTAD (2018), Panteia

\* Entries marked by a single asterisk (\*) have been taken from table 5.1.

\*\* Ships have to anchor upon arriving at seaports, while waiting for a free (un)loading space. This holds true especially at harbours that receive high traffic volumes, like the Port of Rotterdam.

### 5.2.2. Information sources

- Organization:** NEA (Panteia), TNO, Transcare  
**Title (NL):** Factorkosten in het Goederenvervoer  
**Title (EN):** Factor Costs in Freight Transport  
**Year:** 2004  
**Reference / link:** <http://publicaties.minienm.nl/documenten/factorkosten-van-het-goederenvervoer-eeen-analyse-van-de-ontwikke>
- Organization:** Sea-distances.org  
**Title (NL):** Zee afstanden  
**Title (EN):** Sea distances  
**Year:** n/a  
**Reference / link:** <https://sea-distances.org/>
- Organization:** United Nations Conference on Trade and Development (UNCTAD)  
**Title (NL):** Overzicht van Zeetransport 2018  
**Title (EN):** Review of Maritime Transport 2018  
**Year:** 2018  
**Reference / link:** <https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=2245>
- Organization:** MarineTraffic  
**Title (NL):** MarineTraffic: Wereldwijde Schepen Tracking Informatie  
**Title (EN):** MarineTraffic: Global Ship Tracking Intelligence  
**Year:** n/a  
**Reference / link:** <https://www.marinetraffic.com/en/ais/home/centerx:-12.0/centery:24.9/zoom:4>



- Organization: Simpson Spence Young  
Title (NL): Waarde van Schepen  
Title (EN): Ship Values  
Year: n/a  
Reference / link: <https://www.ssyonline.com/free-charts/5-year-old-secondhand-ship-values/>
- Organization: Moore Stephens  
Title (NL): Operationele kosten van schepen: huidige en toekomstige trends  
Title (EN): Ship operating costs: Current and future trends  
Year: 2017  
Reference / link: <https://www.opcostonline.com/>
- Organization: Moore Stephens  
Title (NL): Toekomstige operationele kosten rapport  
Title (EN): Future operating costs report  
Year: 2018  
Reference / link: <https://www.opcostonline.com/>
- Organization: Dr. Jean-Paul Rodrigue, Hofstra University  
Title (NL): Brandstofverbruik op basis van Grootte en Snelheid van Containerschepen  
Title (EN): Fuel Consumption by Containership Size and Speed  
Year: 2009  
Reference / link: [https://transportgeography.org/?page\\_id=5955](https://transportgeography.org/?page_id=5955)
- Organization: CE Delft, Panteia  
Title (NL): STREAM Goederenvervoer 2016  
Title (EN): STREAM Freight Transport 2016  
Year: 2017  
Reference / link: [https://www.ce.nl/publicatie/stream\\_goederenvervoer\\_2016/1854](https://www.ce.nl/publicatie/stream_goederenvervoer_2016/1854)

### 5.3 Cost methodology

This paragraph presents an exhaustive overview of the methodology we used to determine the cost categories for this transport mode. The information sources utilised are listed in section 5.3.6. Several sources listed in section 5.2.2 were consulted again for this paragraph, but are not listed again.

Before addressing the cost categories, it is important to address the main assumption for this section. Accountancy and advisory network Moore Stephens annually publishes OpCosts-reports, which contain actualized data on operational costs of maritime shipping based on a global database of over 3000 ships. We utilised OpCosts 2018 to determine the shares of several different cost (sub)categories, but different sources for other (sub)categories. This is shown in table 5.3.



Table 5.3. Information sources for cost (sub)categories for the maritime transport mode.

<b>Cost (sub)category</b>	<b>Source</b>
Asset depreciations	Simon Spence Young
Insurance	OpCosts (Moore Stephens)
Interest	Simon Spence Young
Maintenance and repairs (fixed)	OpCosts (Moore Stephens)
Bunkering	Expert consultation
Stores, supplies and spares	OpCosts (Moore Stephens)
Maintenance and repairs (variable)	OpCosts (Moore Stephens)
Staff costs	OpCosts (Moore Stephens)
Mode-specific costs	Port of Rotterdam
General operating costs	OpCosts (Moore Stephens)

Additional explanations on the division of costs among categories is provided in the corresponding sections below.

### 5.3.1. Fixed costs

The following fixed cost subcategories exist for this transport mode:

- Depreciations of capital assets (a)
- Insurance costs (b)
- Interest costs (c)
- Maintenance and repairs; percentage of total depends on vehicle type (d)

#### 5.3.1a. Depreciations of capital assets

For our calculations on depreciations (and interest) costs, we drew upon an online database by shipbroker Simpson Spence Young (SSY). This database contains data on the value of used ships – five years old – which was utilised to calculate the market value of new ships. This is based on the lifetime and depreciation period of the assets, which is set at 20 years. The residual value for a fully depreciated vessel is around 10% of the original purchase price (market value). The figures we have used in calculating the CFFT are presented in table 5.4.

Table 5.4. Capital data on maritime transport ships.

	<b>Bulk carrier</b>	<b>Tanker</b>	<b>Container carrier</b>
Value of used ship (5 y.o.)	22.500.000	35.750.000	26.775.000
Estimation of market value	29.032.258	46.129.033	34.548.387
Residual value	2.903.226	4.612.903	3.454.839
Annual depreciation (€)	1.306.452	2.075.807	1.554.677

Source: Simpson Spence Young

#### 5.3.1b. Insurance costs

We have calculated total insurance costs for 2018, as well as the development, by utilizing the figures for daily operating cost and cost division from Moore Stephens (2018). The same holds true for 2016 and 2017, which allowed us to calculate cost development percentages.

#### 5.3.1c. Interest costs

The figures for annual interest costs in this study have been calculated by a formula, which is based on market value and residual value of ships. These values have been taken for the database by SSY. Interest rates on large transport ships were rather volatile during 2018, but were generally on the rise. We opted for an informed estimate of average rate 2,5%. This leads us to the following formula:



0,5 \* (estimated market value – residual value) \* 2,5%

Interest cost development is assumed to be equal between the maritime and inland waterway transport modes.

#### 5.3.1d. Maintenance and repairs

Moore Stephens also publishes absolute fixed costs for maintenance and repairs, which were used for this subcategory – both for absolute values for 2018 as well as for determining cost development.

### **5.3.2. Variable costs**

The following variable subcategories exist for maritime transport: maintenance and repairs (a), bunkering (b) and stores, supplies and spares (c).

#### 5.3.2a. Maintenance and repairs

Moore Stephens (2018) denotes that variable costs for maintenance and repairs represent 13%, 15% and 14% of the costs listed in that publication for bulk carriers, tankers and container carriers respectively. We utilised these relative costs to calculate actual costs for 2018. Moore Stephens also publishes cost development figures for variable maintenance and repair.

#### 5.3.2b. Bunkering

Bunkering is the naval terminology for refuelling by from a specialized bunker ship. We have consulted an expert on maritime shipping to find a satisfactory figure for daily fuel usage of a container carrier. The general consensus in the shipping world is that an average bulk carrier consumes ca. 54 tonnes of fuel, whereas a tanker consumes ca. 53 tonnes and a container carrier ca. 50 tonnes per day. To find the total fuel usage, the total navigation time for each vessel type had to be calculated. This is 312 days for bulk carriers, 324 days for tanker and 263 days for container carriers. Daily fuel usage was related to total annual navigation time to arrive at annual fuel usage. This last figure was multiplied by the average price for fuel oil in 2018: €330 per ton.

Cost development for bunkering is assumed to be equal between the maritime and inland waterway transport modes. This is because both fuels, fuel oil and gas oil respectively, are heavily reliant on the international crude oil price.

#### 5.3.2c. Stores, supplies and spares

Moore Stephens (2018) denotes that stores, supplies and spares represent 13%, 11% and 12% of the costs listed in that publication for bulk carriers, tankers and container carriers respectively. We utilised these relative costs to calculate actual stores, supplies and spares costs for 2018. Moore Stephens also publishes cost development figures for stores, supplies and spares.

### **5.3.3. Staff costs**

Moore Stephens (2018) denotes that staff costs represent 47%, 52% and 50% of the costs listed in that publication for bulk carriers, tankers and container carriers respectively. We utilised these relative costs to calculate actual staff costs for 2018. Staff costs are defined as follows: the total amount required by a business to have labour performed by salaried employees. Staff costs consist of gross wages, social (security) charges, pension contributions and supplements that apply to all personnel. Figures published by Moore Stephens were also utilised for determining cost development.



#### 5.3.4. Mode-specific costs

The only type of mode-specific costs for maritime transport is port dues. Port dues are to be paid to port authorities and the tariff per ship is determined by the time in port, docking location, gross tonnage and the quantity of transshipment. Port dues may vary considerably per harbour, which complicates selecting a value for this cost subcategory. However, the one constant in all routes we have utilised – and the majority of shipping bound for the Netherlands in general – is the Port of Rotterdam. Therefore, the amounts included in the CFFT are based on the port dues document by the Port of Rotterdam. We followed their calculation method, and applied it to the ships of table 5.1 combined with the routes of table 5.2. The Port of Rotterdam annually communicates the port due price increases in the form of press releases, which we utilised to determine mode-specific cost development. See Port of Rotterdam (2016).

#### 5.3.5. General operating costs

This cost category includes administration, communication, overhead and related. Moore Stephens (2018) denotes that general operating costs represent 17%, 14% and 15 % of total operating costs for bulk carriers, tankers and container carriers respectively. We utilised these relative costs to calculate actual general operating costs for 2018.

#### 5.3.6. Information sources

- Organization: Port of Rotterdam  
Title (NL): Havengelden  
Title (EN): Seaport dues  
Year: 2020  
Reference / link: <https://www.portofrotterdam.com/sites/default/files/general-terms-and-conditions-including-port-tariffs-2020.pdf?token=ItqGenYF>
- Organization: Danish Ship Finance  
Title (NL): Scheepvaart Marktoverzicht: November 2018  
Title (EN): Shipping Market Review: November 2018  
Year: 2018  
Reference / link: <https://www.shipfinance.dk/media/1851/shipping-market-review-november-2018.pdf>
- Organization: Port of Rotterdam  
Title (NL): Rotterdamse havengelden zullen opnieuw minder snel groeien dan het inflatiepercentage  
Title (EN): Rotterdam port tariffs will once again increase by less than the rate of inflation  
Year: 2016  
Reference / link: <https://www.portofrotterdam.com/en/news-and-press-releases/rotterdam-port-tariffs-will-once-again-increase-by-less-than-the-rate-of>

### 5.4 Mode-specific methodological remarks

There are no mode-specific methodological remarks for maritime transport.

### 5.5 Cost Figures (2018)

The CFFT for maritime transport for 2018 are presented in the next table.



Table 5.5. Cost figures for maritime transport. Figures are in euros (€) for 2018.

<b>Absolute costs</b>	<b>Bulker</b>	<b>Tanker</b>	<b>Carrier</b>
Fixed costs	2.564.231	4.102.678	3.004.799
Variable costs	6.078.095	6.404.561	4.977.882
Staff costs	934.784	1.477.177	1.227.658
Mode-specific costs	470.104	471.941	1.476.237
General operating costs	338.113	397.701	368.298
Total annual costs	10.385.328	12.854.059	11.054.875
<b>Costs per kilometre</b>	<b>Bulker</b>	<b>Tanker</b>	<b>Carrier</b>
Fixed costs	18,79	25,40	18,38
Variable costs	44,53	39,66	30,45
Staff costs	6,85	9,15	7,51
Mode-specific costs	3,44	2,92	9,03
General operating costs	2,48	2,46	2,25
Total costs per km	76,08	79,59	67,61
<b>Costs per hour</b>	<b>Bulker</b>	<b>Tanker</b>	<b>Carrier</b>
Fixed costs	310	495	363
Variable costs	734	773	601
Staff costs	113	178	148
Mode-specific costs	57	57	178
General operating costs	41	48	44
Total costs per hour	1.254	1.552	1.335
<b>Costs per tonne-kilometre</b>	<b>Bulker</b>	<b>Tanker</b>	<b>Carrier</b>
Fixed costs	0,0008	0,0016	0,0004
Variable costs	0,0019	0,0024	0,0006
Staff costs	0,0003	0,0006	0,0001
Mode-specific costs	0,0001	0,0002	0,0002
General operating costs	0,0001	0,0002	0,0000
Total costs per tonkm	0,0032	0,0049	0,0013
<b>Costs per tonne per hour</b>	<b>Bulker</b>	<b>Tanker</b>	<b>Carrier</b>
Fixed costs	0,013	0,030	0,007
Variable costs	0,031	0,047	0,012
Staff costs	0,005	0,011	0,003
Mode-specific costs	0,002	0,003	0,003
General operating costs	0,002	0,003	0,001
Total costs per tonne per hour	0,053	0,095	0,026
<b>(Un)loading and waiting</b>	<b>Bulker</b>	<b>Tanker</b>	<b>Carrier</b>
Loading: costs per hour	463,42	721,93	555,65
Unloading: costs per hour	463,42	721,93	555,65
Waiting: cost per hour	463,42	721,93	555,65



## 5.6 Cost development (2016-2018)

Table 5.6 shows the cost development for 2016-2018, in the form of percentage-based changes relative to the year before. These percentages are based on annual average costs for both years.

Table 5.6. Cost development percentages for the maritime mode.

	Bulk carrier		Tanker		Container carrier	
	2016/2017	2017/2018	2016/2017	2017/2018	2016/2017	2017/2018
<b>Fixed costs</b>						
Depreciations	0,5%	0,5%	0,5%	0,5%	0,5%	0,5%
Insurance	-4,1%	-7,7%	-4,1%	-7,7%	-4,1%	-7,7%
Interest	9,1%	2,3%	9,1%	2,3%	9,1%	2,3%
Maintenance and repair	1,7%	1,7%	1,7%	2,1%	1,7%	2,6%
<b>Variable costs</b>						
Maintenance and repair	-1,7%	0,6%	-1,7%	0,6%	-1,7%	0,6%
Bunkering	14,5%	16,3%	14,5%	16,3%	14,5%	16,3%
Stores, supplies and spares	-3,5%	-4,9%	-3,5%	-4,9%	-3,5%	-4,9%
<b>Staff costs</b>	-0,1%	-1,1%	-0,5%	-1,8%	-0,6%	0,0%
<b>Mode-specific costs</b>	0,3%	1,0%	0,3%	1,0%	0,3%	1,0%
<b>General operating costs</b>	1,0%	1,0%	0,9%	0,9%	0,5%	0,5%



## 6. Railway transport

### 6.1 Introduction and general information

Railway transport denotes freight transport between railway terminals by freight trains. The Dutch rail network consists of a total of 7219 km of railway. Roughly 75% of this has multiple parallel tracks and also ca. 75% has been electrified. In the railway transport mode, different types of trains are being used. However, the model and type of locomotives and wagons is not the determining factor for the function of the train. We have selected the three main functions of rail transport to base our analysis on.

The three main functions of trains in this report are charter trains, wagon load trains and shuttles. Charter trains are specifically loaded and utilised to service a single client. This main function of rail transport is exclusively used by clients whose volume is large enough to load an entire train. Generally, both the shipper and receiver of freight are large (industrial) companies with their own private rail connection and railyard. The second main function of railway transport is wagon load trains, or mixed goods trains. These trains are composed of all-purpose covered freight wagons, and are utilised by smaller scale clients whose loads are bundled to create sufficient volume to warrant a freight train journey. Oftentimes, a logistics service provider or freight forwarder assists the clients in booking cargo slots on the trains. Finally, the third main function is shuttle trains. A shuttle train simply runs a single route between two points, although it can make multiple stops along its route. This is ideal for reliable high volume freight, as shuttles provide the highest freight throughput capacity of all three main functions. However, in contrast to charter trains, shippers and recipients generally do not have their own rail facilities. As such, shuttles are almost exclusively used for container transport between railway terminals. Figure 6.1 provides an overview of the three main functions and their relation to the ten commodity groups.



Figure 6.5 The three main functions of trains analysed for the railway transport mode and the commodity groups they transport. The colour scheme follows the same principle as in figure 2.1: blue signifies dry bulk, yellow signifies liquid bulk, green signifies break bulk and orange signifies containerized.



Source: Panteia

## 6.2 Assumptions

This paragraph presents an exhaustive overview of the assumptions we used to calculate the CFFT for the railway transport mode. The information sources utilised are listed in section 6.2.2.

### 6.2.1. Non-cost data

As described above, we have discerned three main functions for freight trains. To be able to perform the necessary calculations, the following information is needed for each combination of main function and commodity group: average tonnage, time in use, distance travelled and the utilisation rate. These figures, as well as cost figures used in paragraphs 6.3-6.6, have been acquired from different sources. Firstly, Panteia owns a model for cost calculation in railway transport. This model has been constructed in 2008, as part of Panteia, RailRelease.com and Railistics (2008), and is updated annually. As such, interviews with rail freight operators are conducted periodically (not annually but ad hoc), to update our information. Secondly, several interviews with railway freight transport operators and sector experts have been conducted to obtain auxiliary information from practice. The questions used for those interviews can be found in Appendix F. Thirdly, figures for the utilisation rate have been taken from CE Delft and Panteia (2016). Fourthly, several publicly available statistical databanks were consulted as well: CBS and Spoordata by ProRail (Dutch rail infrastructure operator). Note that due to rail transport generally being used for long haul, figures have been gathered from both Dutch rail companies and rail freight operators from Germany and



Belgium. The Dutch and German rail freight transport sectors and areas are particularly interconnected.

Information on train composition has been obtained from sector experts. Average tonnage has been set at 2.800 tonnes for most combinations of train function and commodity group. 2.800 tonnes is used as a rule of thumb in the industry for the maximum tractive effort of a Bombardier TRAXX locomotive. Single-locomotive freight train compositions are most common. Through market consultation we found that the TRAXX-type locomotive is the most commonly operated in rail freight transport in the Netherlands. Table 6.1 shows the data for the railway transport mode:

Table 6.1. Data on the railway transport mode.

Main function	Commodity group	No. wagons	Average tonnage (tonne)	Time in use (hr/yr)	Distance tra-veled (km/yr)	Utili-sation rate (%)
Charter trains	Agricultural and food products	35	2.800	3.600	178.500	32
Charter trains	Coal, brown coal and cokes	35	2.800	3.600	178.500	48
Charter trains	Ores*	35	4.000	3.600	178.500	54
Charter trains	Salt, sand, gravel and clay	35	2.800	3.600	178.500	48
Charter trains	Crude oil and natural gas	30	2.800	3.600	178.500	32
Charter trains	Chemical products	30	2.800	3.600	178.500	32
Charter trains	Miscellaneous minerals	35	2.800	3.600	178.500	48
Charter trains	Base metals and metal products	35	2.800	3.600	178.500	32
Wagon load trains	Miscellaneous goods	30	2.800	3.600	178.500	54
Shuttle trains	Containers	19	2.800	3.600	178.500	32

Source: Panteia

\* Ore trains contain two locomotives.

## 6.2.2. Information sources

- Organization:** Panteia, RailRelease.com, Railistics  
**Title (NL):** n/a  
**Title (EN):** Cost and Performance of European Rail Freight Transportation  
**Year:** 2008  
**Reference / link:**
- Organization:** CE Delft  
**Title (NL):** STREAM Goederenvervoer 2016  
**Title (EN):** STREAM Freight Transport 2016  
**Year:** 2017  
**Reference / link:** [https://www.ce.nl/publicatie/stream\\_goederenvervoer\\_2016/1854](https://www.ce.nl/publicatie/stream_goederenvervoer_2016/1854)
- Organization:** ProRail  
**Title (NL):** SpoorData  
**Title (EN):** RailData  
**Year:** n/a  
**Reference / link:** <https://www.spoordata.nl/?>

## 6.3 Cost methodology

This paragraph presents an exhaustive overview of the methodology we used to determine the cost categories for rail freight transport. The information sources utilised are listed in section 6.3.6. Several sources listed in section 6.2.2 were consulted again for this paragraph, but are not listed again in this paragraph. For the railway transport mode, a number of railway freight transport



operators have also been consulted via interviews to gather additional data, as well as practical information. The parties that have been consulted will not be named in this report, as the data acquired from them contains competition-sensitive information.

### **6.3.1. Fixed costs**

The cost types that belong to fixed costs are based on Panteia's railway cost model. The following list provides an overview of fixed cost subcategories:

- Lease of locomotives
- Lease of wagons
- Lease of auxiliary assets

Contrary to the other transport modes in this study, assets in rail transport are nearly always leased rather than purchased (or rented). Annual reports, sector experts and entrepreneurs were consulted to determine the lease cost of each type of asset (per day). The annual reports of DB Cargo and Hupac have been included in the reference list (DB Cargo (2018), Hupac (2018)). Note that there are no cost (sub)categories for maintenance and repairs for this transport mode. This is because all assets are leased, and costs of maintenance and repairs are included in the price; the leasing company takes care of these matters.

Data on the historical development of asset-related costs has been collected by consultation of entrepreneurs in the railway freight sector. This applies to both this section and the following two, as all three include asset leases. The cost development itself is shown in paragraph 6.5.

### **6.3.2. Variable costs**

The only variable cost subcategory for the railway transport mode is energy costs. Energy costs for rail transport depend fully on the price for electricity, as the majority of rail traffic in the Netherlands and Germany uses electric locomotives. The figures for energy costs have been drawn from annual figures reports. To track the development of energy costs, we have consulted the energy (price) database by CBS.

### **6.3.3. Staff costs**

Staff costs have been determined based on six interviews with rail freight transport operators. Note that this cost category only includes wages, social charges and wage taxes for train drivers, not for other personnel. Staff costs for non-driver personnel are part of general operating costs. Staff costs for railway transport are defined as follows: the total amount required by a business to have labour performed by salaried employees. Staff costs consist of gross wages, social (security) charges, pension contributions and compensations. The development of wages over time has been determined by consulting the collective labour agreement for railway personnel.

### **6.3.4. Mode-specific costs**

Two mode-specific cost subcategories exist for the railway transport mode: track access charges (a) and shunting costs (b).

#### 6.3.4a. Track access charges

Railway infrastructure operators charge rail freight companies for using their infrastructure in the form of track access charges. For this study, we consulted ProRail (2018) and DB Netze (2018). An average charge per kilometre has been determined and applied to the CFFT calculations.



#### 6.3.4b. Shunting costs

Shunting charges in practice are based on actual shunting times and deployment of shunting engines. However, for this calculation we determined market averages based on figures provided by entrepreneurs for 2016, 2017 and 2018.

#### 6.3.5. General operating costs

This cost category contains the costs of administration, communication, overhead and related. Also included here are the costs incurred for parking trains on stabling tracks. General operating costs have been assumed to be 15% of total costs for this transport mode. Rail freight operators indicated that overhead generally amounts to this percentage.

#### 6.3.6. Information sources

- Organization: CBS  
Title (NL): Welke cijfers zijn er over energieprijzen?  
Title (EN): Which figures exist on energy pricing?  
Year: 2019  
Reference / link: <https://www.cbs.nl/nl-nl/faq/specifiek/welke-cijfers-zijn-er-over-energieprijzen->
- Organization: NS  
Title (NL): CAO NS 2017-2020  
Title (EN): Collective Labour Agreement Dutch Railways 2017-2020  
Year: 2017  
Reference / link: <https://werkenbijns.nl/content/uploads/2018/10/CAO-NS-2017-2020-DIGITAL.pdf>
- Organization: ProRail  
Title (NL): Kosten voor het gebruik van het spoor  
Title (EN): Track access charges for usage of railways  
Year: 2018  
Reference / link: <https://www.prorail.nl/vervoerders/kosten-voor-het-gebruik-van-het-spoor>
- Organization: DB Netze  
Title (NL): n/a  
Title (EN): Facility Pricing System 2018 of DB Netz G  
Year: 2018  
Reference / link: [https://fahrweg.dbnetze.com/resource/blob/1367442/6bb83f871994a506ec2cea2f76f2b707/aps-broschure2018\\_en-data.pdf](https://fahrweg.dbnetze.com/resource/blob/1367442/6bb83f871994a506ec2cea2f76f2b707/aps-broschure2018_en-data.pdf)
- Organization: Deutsche Bahn Cargo  
Title (NL): Deutsche Bahn 2018 Jaarrapport: Op weg naar een beter spoorwegsysteem  
Title (EN): Deutsche Bahn 2018 Integrated Report: On track towards a better railway  
Year: 2018  
Reference / link: [https://ir.deutschebahn.com/fileadmin/Englisch/2019e/Anhaenge/IB18\\_e\\_web\\_04.pdf](https://ir.deutschebahn.com/fileadmin/Englisch/2019e/Anhaenge/IB18_e_web_04.pdf)



- Organization: Hupac (formerly ERS Railways)  
Title (NL): Jaarverslag 2018  
Title (EN): Annual report 2018  
Year: 2018  
Reference / link: [https://www.hupac.com/Relazione-sulla-Gestione-2018-inglesepdf-4dfa6e00?i=1&MasterId=q1\\_3761](https://www.hupac.com/Relazione-sulla-Gestione-2018-inglesepdf-4dfa6e00?i=1&MasterId=q1_3761)

#### **6.4 Mode-specific methodological remarks**

The information and data utilised for the railway transport mode was mainly gathered through market consultation. Other sources were utilised as well: annual reports from railway transport operators and other documents from related parties, like the CLA, track access charges publications and the CBS database on electricity pricing.

#### **6.5 Cost Figures (2018)**

The tables below present the CFFT for railway transport per type of cargo for 2018. CFFT per commodity group can be found in appendix C.



Table 6.2. Cost figures for the railway freight transport mode per type of cargo. Figures are in euros (€) for 2018.

	<b>Charter</b>		<b>Wagon load</b>	<b>Shuttle</b>
<b>Absolute costs</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	1.220.285	1.074.462	1.771.440	944.911
Variable costs	527.313	527.313	1.619.313	527.313
Staff costs	252.000	252.000	601.440	252.000
Mode-specific costs	674.225	636.688	1.615.738	653.738
General operating costs	401.073	373.569	841.190	356.694
Total annual costs	3.074.896	2.864.031	6.449.120	2.734.655
<b>Costs per kilometre</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	6,83	6,01	9,91	5,29
Variable costs	2,95	2,95	9,06	2,95
Staff costs	1,41	1,41	3,36	1,41
Mode-specific costs	3,77	3,56	9,04	3,66
General operating costs	2,24	2,09	4,71	2,00
Total costs per km	17,20	16,02	36,08	15,30
<b>Costs per hour</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	338,97	298,46	492,07	262,48
Variable costs	146,48	146,48	449,81	146,48
Staff costs	70,00	70,00	167,07	70,00
Mode-specific costs	187,28	176,86	448,82	181,59
General operating costs	111,41	103,77	233,66	99,08
Total costs per hour	854,14	795,56	1791,42	759,63
<b>Costs per tonne-kilometre</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,005	0,006	0,011	0,006
Variable costs	0,002	0,003	0,010	0,003
Staff costs	0,001	0,001	0,004	0,002
Mode-specific costs	0,003	0,003	0,010	0,004
General operating costs	0,002	0,002	0,005	0,002
Total costs per tonkm	0,012	0,015	0,040	0,017
<b>Costs per tonne per hour</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Fixed costs	0,24	0,29	0,55	0,29
Variable costs	0,10	0,14	0,50	0,16
Staff costs	0,05	0,07	0,19	0,08
Mode-specific costs	0,13	0,17	0,50	0,20
General operating costs	0,08	0,10	0,26	0,11
Total costs per tonne per hour	0,59	0,76	2,00	0,85
<b>(Un)loading and waiting</b>	<b>Dry bulk</b>	<b>Liquid bulk</b>	<b>Break bulk</b>	<b>Container</b>
Loading: costs per hour	520,38	472,23	892,80	431,56
Unloading: costs per hour	520,38	472,23	892,80	431,56
Waiting: cost per hour	520,38	472,23	892,80	431,56



## 6.6 Cost development (2016-2018)

Development of the main cost categories is presented in the table below. For the railway mode, general operating costs are considered part of the total costs. As such, these are automatically adjusted based on the other categories' mutations. These percentages are based on annual average costs for both years.

Table 6.3. Cost development percentages for the railway mode.

	<b>2016/2017</b>	<b>2017/2018</b>
<b>Fixed costs</b>	1,72%	0,00%
<b>Variable costs</b>	2,20%	2,00%
<b>Staff costs</b>	2,60%	2,30%
<b>Mode-specific costs</b>	-5,80%	1,16%



## 7. Air freight transport

### 7.1 Introduction and general information

Air freight transport denotes freight transport through the air between airports using cargo aircraft. Air freight transport consists of two main methods of operation: full freighter and belly transport. The practice of belly transport denotes the utilisation of excess carrying capacity in aircraft's holds on passenger flights to transport air freight. For calculating CFFT, we chose to disregard belly transport as its costs are nearly impossible to distinguish from passenger transport costs – only dedicated cargo aircraft will be analysed. Also note that a part of air freight is transported by road, yet still considered air freight in statistics. This type of air freight transport is omitted from analysis.

The Netherlands has several commercial airports, five of which are of national importance: Amsterdam Schiphol Airport, Rotterdam The Hague Airport, Eindhoven Airport, Maastricht Aachen Airport and Groningen Airport Eelde. Schiphol Airport is most important by a large margin, as it represented 94% of all air freight volume in 2018. Additionally, Schiphol Airport ranked third as Europe's busiest airport in terms of cargo volume in 2018. The airports of Rotterdam, Eindhoven and Groningen used to handle small volumes as well, but have since ceased this activity. Therefore, Maastricht Aachen Airport is the only location besides Schiphol with air freight handling capacity, with a volume of ca. 125.000 tonnes (6% of the Dutch total) in 2018 (CBS (2019)).

### 7.2 Assumptions

This paragraph presents an exhaustive overview of the assumptions we used to calculate the CFFT air freight transport mode. The information sources utilised are listed in section 7.2.2.

#### 7.2.1. Non-cost data

As stated above, this analysis has been performed for full freighter transport only; belly transport has been omitted. Dedicated freighter aircraft in the Netherlands are low in number and relatively homogenous: 75% is of the same model. Therefore we analysed a single vehicle type and model for air freight transport: the Boeing 747-400 Extended range Freighter (ERF). This aircraft has a maximum carrying capacity of 112 tonnes of cargo and a maximum range of 9.200 kilometres. Specifications for this type of aircraft and figures utilised in this study are provided in table 7.1.

Table 7.1. Specifications for the Boeing 747-400ERF.

Carrying capacity	112 tonnes
Average tonnage	86 tonnes
Time in use	4.567 hr/yr
Distance travelled	3.600.000 km/yr
Utilisation rate	77%

Source: Boeing (2010)

The four types of cargo and ten commodity groups do not feature in the analysis of air freight transport. Air freight transport has inherent limitations to the weights and dimensions that can be transported, which makes the air freight transport mode unsuited for transporting most commodity groups. Although it is possible to load shipping containers (TEU) into certain cargo aircraft, this does not occur frequently. A different type of container, called a unit load device (DLU), is generally preferred over shipping containers. For this analysis, however, DLUs are not considered to belong to the container type of cargo or commodity group. Therefore, in this analysis, freight transported by the air freight transport mode is assumed to belong to commodity group miscellaneous goods (number 8 in figure 2.1).



### 7.2.2. Information sources

- Organization: CBS  
Title (NL): Luchtvaart; cijfers Nederlandse luchthavens van nationaal belang  
Title (EN): Aviation: figures on Dutch airports of national importance  
Year: 2019  
Reference / link:  
<https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37478hvv/table?dl=18CDA>
- Organization: Boeing  
Title (NL): n/a  
Title (EN): 747-400/-400ER Freighters  
Year: 2010  
Reference / link:  
[https://www.boeing.com/resources/boeingdotcom/company/about\\_bca/startup/pdf/freighters/747-400f.pdf](https://www.boeing.com/resources/boeingdotcom/company/about_bca/startup/pdf/freighters/747-400f.pdf)

## 7.3 Cost methodology

This paragraph presents an exhaustive overview of the methodology we used to determine the cost categories for this mode. The information sources utilised are listed in section 7.3.6.

### 7.3.1. Fixed costs

Fixed costs for air freight transport consists of the following: asset depreciations (which include insurance), maintenance and repairs (partially) and miscellaneous fixed costs. The division between fixed and variable costs for maintenance and repair are based on the method of bookkeeping utilised by air freight transport operators. The most important data for determining fixed costs is the market value of (new) aircraft, which are published by the two main manufacturers: Boeing and Airbus. The sources for the pricing of new aircraft are Pilot en Vliegtuig (2018a) and Pilot en Vliegtuig (2018b). Development of fixed costs in air freight transport has been determined by tracking the price development of cargo aircraft by Boeing and Airbus, see Pilot en Vliegtuig (2017a), Pilot en Vliegtuig (2017b) and Pilot en Vliegtuig (2016).

### 7.3.2. Variable costs

Variable costs for air freight transport consist of the following: fuel, maintenance and repairs (partially) and miscellaneous variable costs. Aircraft use kerosene for fuel, and the average fuel usage of a Boeing 747-400ERF is ca. 13.000 liters per flight hour. To track the development of variable costs, we have consulted the database on price development of kerosene by Index Mundi (see section 7.3.6). Kerosene pricing is exclusively listed in US dollar (\$), which we have converted to euro (€) based on the conversion rate for 2018.

### 7.3.3. Staff costs

Staff costs signify the total expenses required by the employer to have labour performed by salaried employees. This cost category includes wages, social charges and wage taxes for pilots but not for supporting ground personnel. We have derived staff costs from interviews. In this analysis, the development of staff costs is based on the mutations of wages et cetera listed in the Collective Labour Agreement for pilots (Loonwijzer (2017)).



#### 7.3.4. Mode-specific costs

Mode-specific costs for this transport mode consist solely of take-off and landing fees. This is a compensation paid by air freight operators to airports for usage of the runways. The cost development of mode-specific costs has been based on annual mutations of take-off and landing fees at Schiphol Amsterdam Airport. We acquired data on take-off and landing fees through interviews.

#### 7.3.5. General operating costs

This cost category includes administration, communication, overhead and other related cost categories. These costs have been found by conducting interviews with air freight transport operators. Miscellaneous cost developments are have been assumed as the averaged cost development of the other four cost categories.

#### 7.3.6. Information sources

- Organization: Loonwijzer  
Title (NL): KLM CAO Vliegers 2018-2019  
Title (EN): KLM Collective Labour Agreement for Pilots 2018-2019  
Year: 2017  
Reference / link: <https://loonwijzer.nl/arbeidsvoorwaarden/caowijzer/cao/990/klm-vliegers>
- Organization: Index Mundi  
Title (NL): Vliegtuigbrandstof Maandelijks Prijs  
Title (EN): Jet Fuel Monthly Price  
Year: n/a  
Reference / link: <https://www.indexmundi.com/commodities/?commodity=jet-fuel&months=60>
- Organization: Pilot en Vliegtuig  
Title (NL): Boeing publiceert prijzen vliegtuigen 2018  
Title (EN): Boeing publishes aircraft pricing for 2018  
Year: 2018 (a)  
Reference / link: <https://www.pilootenvliegtuig.nl/2018/01/23/boeing-publiceert-prijzen-vliegtuigen-2018/>
- Organization: Pilot en Vliegtuig  
Title (NL): Wat kost een Airbus in 2018?  
Title (EN): What is the price of an Airbus in 2018?  
Year: 2018 (b)  
Reference / link: <https://www.pilootenvliegtuig.nl/2018/01/15/kost-airbus-2018/>
- Organization: Pilot en Vliegtuig  
Title (NL): Wat kost een Airbus in 2017?  
Title (EN): What is the price of an Airbus in 2017?  
Year: 2017 (a)  
Reference / link: <https://www.pilootenvliegtuig.nl/2017/01/11/kost-airbus-2017/>



- Organization: Piloot en Vliegtuig  
Title (NL): Boeing geeft 2017 prijzen vliegtuigen vrij  
Title (EN): Boeing publishes the pricing for aircraft in 2017  
Year: 2017 (b)  
Reference / link: <https://www.pilootenvliegtuig.nl/2017/01/11/kost-airbus-2017/>
- Organization: Piloot en Vliegtuig  
Title (NL): Wat kost een Airbus in 2016?  
Title (EN): What is the price of an Airbus in 2016?  
Year: 2016  
Reference / link: <https://www.pilootenvliegtuig.nl/2016/01/14/kost-airbus-2016/>

#### **7.4 Mode-specific methodological remarks**

All absolute cost data for this mode has been collected from air freight operators.

#### **7.5 Cost Figures (2018)**

The CFFT for air freight transport, based on the Boeing 747-400ERF, are presented in table 7.2. Figures are for 2018.



Table 7.2. Cost figures for the air freight transport mode. Figures are in euros (€) for 2018.

<b>Absolute costs</b>	
Fixed costs	9.045.000
Variable costs	32.681.000
Staff costs	6.507.000
Mode-specific costs	5.654.000
General operating costs	3.337.000
Total annual costs	57.224.000
<b>Costs per kilometre</b>	
Fixed costs	2,51
Variable costs	9,08
Staff costs	1,81
Mode-specific costs	1,57
General operating costs	0,93
Total costs per km	15,90
<b>Costs per hour</b>	
Fixed costs	1.981
Variable costs	7.156
Staff costs	1.425
Mode-specific costs	1.238
General operating costs	731
Total costs per hour	12.530
<b>Costs per tonne-kilometre</b>	
Fixed costs	0,03
Variable costs	0,11
Staff costs	0,02
Mode-specific costs	0,02
General operating costs	0,01
Total costs per tonkm	0,18
<b>Costs per tonne per hour</b>	
Fixed costs	22,97
Variable costs	82,98
Staff costs	16,52
Mode-specific costs	14,36
General operating costs	8,47
Total costs per tonne per hour	145,29
<b>(Un)loading and waiting</b>	
Loading: costs per hour	4.135,98
Unloading: costs per hour	4.135,98
Waiting: cost per hour	4.135,98



## 7.6 Cost development (2016-2018)

Development of the main cost categories is presented in the table below. These percentages are based on annual average costs for both years.

Table 7.3. Cost development percentages for the air freight transport mode.

	<b>2016/2017</b>	<b>2017/2018</b>
<b>Fixed costs</b>	2,2%	4,1%
<b>Fuel costs</b>	28,0%	34,7%
<b>Other variable costs</b>	1,4%	1,7%
<b>Staff costs</b>	0,0%	1,8%
<b>Mode-specific costs</b>	-8,2%	2,3%
<b>General operating costs</b>	1,4%	1,7%



## Appendices - overview

Appendix A. Data inland waterway transport

Appendix B. Data road transport

Appendix C. Data railway transport

Appendix D. Glossary and abbreviations

Appendix E. Crewing regulations for inland waterway transport

Appendix F. Interview questions for railway freight transport operators



## Appendix A. Data inland waterway transport

Table A.1. Cost figures for 2018 for **small ships** for the commodity groups: agricultural and food products (agri); coal, brown coal and cokes (coal); salt, sand, gravel and clay (salt) in euros (€).

<b>Absolute costs</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	20.520	20.520	20.520	22.009
Variable costs	24.252	24.252	24.252	24.765
Staff costs	107.953	107.953	107.953	94.878
Mode-specific costs	4.465	4.465	4.465	3.696
General operating costs	8.300	8.300	8.300	8.300
Total annual costs	165.491	165.491	165.491	153.648
<b>Costs per kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	1,03	1,03	1,03	1,00
Variable costs	1,22	1,22	1,22	1,13
Staff costs	5,43	5,44	5,44	4,31
Mode-specific costs	0,22	0,23	0,22	0,17
General operating costs	0,42	0,42	0,42	0,38
Total costs per km	8,33	8,34	8,33	6,98
<b>Costs per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	5,36	5,36	5,36	6,15
Variable costs	6,33	6,33	6,33	6,92
Staff costs	28,19	28,19	28,19	26,50
Mode-specific costs	1,17	1,17	1,17	1,03
General operating costs	2,17	2,17	2,17	2,32
Total costs per hour	43,21	43,21	43,21	42,92
<b>Costs per tonne-kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	0,004	0,004	0,004	0,004
Variable costs	0,005	0,005	0,005	0,005
Staff costs	0,022	0,022	0,022	0,018
Mode-specific costs	0,001	0,001	0,001	0,001
General operating costs	0,002	0,002	0,002	0,002
Total costs per tonkm	0,034	0,033	0,034	0,030
<b>Costs per tonne per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	0,022	0,022	0,022	0,026
Variable costs	0,026	0,025	0,026	0,029
Staff costs	0,116	0,113	0,115	0,113
Mode-specific costs	0,005	0,005	0,005	0,004
General operating costs	0,009	0,009	0,009	0,010
Total costs per tonne per hour	0,177	0,173	0,176	0,182
<b>(Un)loading and waiting</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Loading: costs per hour	35,71	35,71	35,71	34,97
Unloading: costs per hour	35,71	35,71	35,71	34,97
Waiting: cost per hour	35,71	35,71	35,71	34,97



Table A.1. (continued) Cost figures for 2018 for **small ships** for the commodity groups: miscellaneous goods (misc); base metals and metal products (metals) and containers in euros (€).

<b>Absolute costs</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	20.520	20.520	29.260
Variable costs	24.252	24.252	27.424
Staff costs	107.953	107.953	107.953
Mode-specific costs	4.465	4.465	7.987
General operating costs	8.300	8.300	8.300
Total annual costs	165.491	165.491	180.924
<b>Costs per kilometre</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	1,01	1,03	1,22
Variable costs	1,19	1,22	1,15
Staff costs	5,31	5,44	4,51
Mode-specific costs	0,22	0,22	0,33
General operating costs	0,41	0,42	0,35
Total costs per km	8,14	8,33	7,56
<b>Costs per hour</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	5,36	5,36	7,64
Variable costs	6,33	6,33	7,16
Staff costs	28,19	28,19	28,19
Mode-specific costs	1,17	1,17	2,09
General operating costs	2,17	2,17	2,17
Total costs per hour	43,21	43,21	47,24
<b>Costs per tonne-kilometre</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,006	0,004	0,014
Variable costs	0,007	0,005	0,013
Staff costs	0,031	0,022	0,050
Mode-specific costs	0,001	0,001	0,004
General operating costs	0,002	0,002	0,004
Total costs per tonkm	0,048	0,034	0,084
<b>Costs per tonne per hour</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,031	0,022	0,085
Variable costs	0,037	0,026	0,080
Staff costs	0,166	0,115	0,315
Mode-specific costs	0,007	0,005	0,023
General operating costs	0,013	0,009	0,024
Total costs per tonne per hour	0,254	0,176	0,528
<b>(Un)loading and waiting</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Loading: costs per hour	35,71	35,71	37,99
Unloading: costs per hour	35,71	35,71	37,99
Waiting: cost per hour	35,71	35,71	37,99



Table A.2. Cost figures for 2018 for **medium ships** for the commodity groups: agricultural and food products (agri); coal, brown coal and cokes (coal); salt, sand, gravel and clay (salt) in euros (€).

<b>Absolute costs</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	66.284	66.284	66.284	68.751
Variable costs	58.570	58.570	58.570	63.214
Staff costs	140.453	140.453	140.453	142.127
Mode-specific costs	9.406	9.406	9.406	10.934
General operating costs	12.180	12.180	12.180	12.180
Total annual costs	286.893	286.893	286.893	297.206
<b>Costs per kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	2,66	2,69	2,67	2,49
Variable costs	2,35	2,38	2,36	2,29
Staff costs	5,63	5,70	5,65	5,15
Mode-specific costs	0,38	0,38	0,38	0,40
General operating costs	0,49	0,49	0,49	0,44
Total costs per km	11,51	11,64	11,55	10,77
<b>Costs per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	16,69	16,69	16,69	17,19
Variable costs	14,75	14,75	14,75	15,81
Staff costs	35,37	35,37	35,37	35,54
Mode-specific costs	2,37	2,37	2,37	2,73
General operating costs	3,07	3,07	3,07	3,05
Total costs per hour	72,25	72,25	72,25	74,32
<b>Costs per tonne-kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	0,005	0,004	0,005	0,004
Variable costs	0,004	0,004	0,004	0,004
Staff costs	0,010	0,009	0,010	0,009
Mode-specific costs	0,001	0,001	0,001	0,001
General operating costs	0,001	0,001	0,001	0,001
Total costs per tonkm	0,021	0,019	0,020	0,018
<b>Costs per tonne per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	0,031	0,027	0,029	0,029
Variable costs	0,027	0,024	0,026	0,027
Staff costs	0,065	0,056	0,062	0,060
Mode-specific costs	0,004	0,004	0,004	0,005
General operating costs	0,006	0,005	0,005	0,005
Total costs per tonne per hour	0,133	0,115	0,127	0,126
<b>(Un)loading and waiting</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Loading: costs per hour	55,13	55,13	55,13	55,78
Unloading: costs per hour	55,13	55,13	55,13	55,78
Waiting: cost per hour	55,13	55,13	55,13	55,78



Table A.2. (continued) Cost figures for 2018 for **medium ships** for the commodity groups: crude oil and natural gas (oil); chemical; miscellaneous minerals (minerals); miscellaneous goods (misc) in euros (€).

<b>Absolute costs</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	213.043	213.043	213.043	66.284
Variable costs	61.834	61.834	61.834	58.570
Staff costs	155.543	155.543	155.543	140.453
Mode-specific costs	9.581	9.581	9.581	9.406
General operating costs	12.180	12.180	12.180	12.180
Total annual costs	452.180	452.180	452.180	286.893
<b>Costs per kilometre</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	7,94	7,93	8,00	2,59
Variable costs	2,30	2,30	2,32	2,29
Staff costs	5,80	5,79	5,84	5,48
Mode-specific costs	0,36	0,36	0,36	0,37
General operating costs	0,45	0,45	0,46	0,48
Total costs per km	16,86	16,84	16,97	11,20
<b>Costs per hour</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	52,54	52,54	52,54	16,69
Variable costs	15,25	15,25	15,25	14,75
Staff costs	38,36	38,36	38,36	35,37
Mode-specific costs	2,36	2,36	2,36	2,37
General operating costs	3,00	3,00	3,00	3,07
Total costs per hour	111,51	111,51	111,51	72,25
<b>Costs per tonne-kilometre</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	0,018	0,018	0,016	0,007
Variable costs	0,005	0,005	0,005	0,007
Staff costs	0,013	0,013	0,012	0,016
Mode-specific costs	0,001	0,001	0,001	0,001
General operating costs	0,001	0,001	0,001	0,001
Total costs per tonkm	0,038	0,039	0,035	0,032
<b>Costs per tonne per hour</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	0,119	0,121	0,108	0,007
Variable costs	0,035	0,035	0,031	0,007
Staff costs	0,087	0,088	0,079	0,016
Mode-specific costs	0,005	0,005	0,005	0,001
General operating costs	0,007	0,007	0,006	0,001
Total costs per tonne per hour	0,253	0,256	0,230	0,032
<b>(Un)loading and waiting</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Loading: costs per hour	93,90	93,90	93,90	55,13
Unloading: costs per hour	93,90	93,90	93,90	55,13
Waiting: cost per hour	93,90	93,90	93,90	55,13



Table A.2. (continued) Cost figures for 2018 for **medium ships** for the commodity groups: base metals and metal products (metal); containers in euros (€).

<b>Absolute costs</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	66.284	102.287
Variable costs	58.570	69.300
Staff costs	140.453	183.584
Mode-specific costs	9.406	14.071
General operating costs	12.180	12.180
Total annual costs	286.893	381.421
<b>Costs per kilometre</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	2,68	3,01
Variable costs	2,37	2,04
Staff costs	5,68	5,40
Mode-specific costs	0,38	0,41
General operating costs	0,49	0,36
Total costs per km	11,60	11,22
<b>Costs per hour</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	16,69	21,86
Variable costs	14,75	14,81
Staff costs	35,37	39,24
Mode-specific costs	2,37	3,01
General operating costs	3,07	2,60
Total costs per hour	72,25	81,52
<b>Costs per tonne-kilometre</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,004	0,009
Variable costs	0,004	0,006
Staff costs	0,009	0,016
Mode-specific costs	0,001	0,001
General operating costs	0,001	0,001
Total costs per tonkm	0,019	0,033
<b>Costs per tonne per hour</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,028	0,064
Variable costs	0,025	0,044
Staff costs	0,059	0,116
Mode-specific costs	0,004	0,009
General operating costs	0,005	0,008
Total costs per tonne per hour	0,121	0,240
<b>(Un)loading and waiting</b>	<b>Metals</b>	<b>Containers</b>
Loading: costs per hour	55,13	63,70
Unloading: costs per hour	55,13	63,70
Waiting: cost per hour	55,13	63,70



Table A.3. Cost figures for 2018 for **large ships** for the commodity groups: agricultural and food products (agri); coal, brown coal and cokes (coal); salt, sand, gravel and clay (salt) in euros (€).

<b>Absolute costs</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	200.804	200.804	200.804	208.575
Variable costs	114.086	114.086	114.086	123.411
Staff costs	191.048	191.048	191.048	193.325
Mode-specific costs	14.780	14.780	14.780	17.181
General operating costs	18.519	18.519	18.519	18.519
Total annual costs	539.237	539.237	539.237	561.012
<b>Costs per kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	6,21	6,25	6,24	5,84
Variable costs	3,53	3,55	3,55	3,46
Staff costs	5,91	5,94	5,94	5,42
Mode-specific costs	0,46	0,46	0,46	0,48
General operating costs	0,57	0,58	0,58	0,52
Total costs per km	16,69	16,78	16,77	15,72
<b>Costs per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	46,50	46,50	46,50	47,97
Variable costs	26,42	26,42	26,42	28,38
Staff costs	44,24	44,24	44,24	44,46
Mode-specific costs	3,42	3,42	3,42	3,95
General operating costs	4,29	4,29	4,29	4,26
Total costs per hour	124,88	124,88	124,88	129,01
<b>Costs per tonne-kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	0,007	0,006	0,007	0,006
Variable costs	0,004	0,004	0,004	0,003
Staff costs	0,007	0,006	0,006	0,005
Mode-specific costs	0,001	0,000	0,000	0,000
General operating costs	0,001	0,001	0,001	0,001
Total costs per tonkm	0,019	0,017	0,018	0,015
<b>Costs per tonne per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	0,054	0,048	0,049	0,047
Variable costs	0,030	0,027	0,028	0,028
Staff costs	0,051	0,046	0,046	0,043
Mode-specific costs	0,004	0,004	0,004	0,004
General operating costs	0,005	0,004	0,004	0,004
Total costs per tonne per hour	0,144	0,129	0,131	0,126
<b>(Un)loading and waiting</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Loading: costs per hour	95,04	95,04	95,04	96,68
Unloading: costs per hour	95,04	95,04	95,04	96,68
Waiting: cost per hour	95,04	95,04	95,04	96,68



Table A.3. (continued) Cost figures for 2018 for **large ships** for the commodity groups: crude oil and natural gas (oil); chemical; miscellaneous minerals (minerals); miscellaneous goods (misc) in euros (€).

<b>Absolute costs</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	460.530	460.530	460.530	200.804
Variable costs	147.346	147.346	147.346	114.086
Staff costs	371.740	371.740	371.740	191.048
Mode-specific costs	19.352	19.352	19.352	14.780
General operating costs	18.519	18.519	18.519	18.519
Total annual costs	1.017.487	1.017.487	1.017.487	539.237
<b>Costs per kilometre</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	9,94	9,85	9,92	6,14
Variable costs	3,18	3,15	3,17	3,49
Staff costs	8,02	7,95	8,01	5,84
Mode-specific costs	0,42	0,41	0,42	0,45
General operating costs	0,40	0,40	0,40	0,57
Total costs per km	21,95	21,76	21,92	16,49
<b>Costs per hour</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	73,99	73,99	73,99	46,50
Variable costs	23,67	23,67	23,67	26,42
Staff costs	59,73	59,73	59,73	44,24
Mode-specific costs	3,11	3,11	3,11	3,42
General operating costs	2,98	2,98	2,98	4,29
Total costs per hour	163,48	163,48	163,48	124,88
<b>Costs per tonne-kilometre</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	0,012	0,013	0,012	0,009
Variable costs	0,004	0,004	0,004	0,005
Staff costs	0,009	0,011	0,010	0,009
Mode-specific costs	0,000	0,001	0,001	0,001
General operating costs	0,000	0,001	0,000	0,001
Total costs per tonkm	0,026	0,030	0,027	0,025
<b>Costs per tonne per hour</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Fixed costs	0,088	0,101	0,090	0,071
Variable costs	0,028	0,032	0,029	0,040
Staff costs	0,071	0,082	0,073	0,067
Mode-specific costs	0,004	0,004	0,004	0,005
General operating costs	0,004	0,004	0,004	0,007
Total costs per tonne per hour	0,194	0,223	0,199	0,190
<b>(Un)loading and waiting</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Misc</b>
Loading: costs per hour	136,69	136,69	136,69	95,04
Unloading: costs per hour	136,69	136,69	136,69	95,04
Waiting: cost per hour	136,69	136,69	136,69	95,04



Table A.3. (continued) Cost figures for 2018 for **large ships** for the commodity groups: base metals and metal products (metal); containers in euros (€).

<b>Absolute costs</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	200.804	251.918
Variable costs	114.086	166.368
Staff costs	191.048	403.644
Mode-specific costs	14.780	30.707
General operating costs	18.519	18.519
Total annual costs	539.237	871.157
<b>Costs per kilometre</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	6,25	4,98
Variable costs	3,55	3,29
Staff costs	5,95	7,98
Mode-specific costs	0,46	0,61
General operating costs	0,58	0,37
Total costs per km	16,78	17,23
<b>Costs per hour</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	46,50	36,92
Variable costs	26,42	24,38
Staff costs	44,24	59,16
Mode-specific costs	3,42	4,50
General operating costs	4,29	2,71
Total costs per hour	124,88	127,68
<b>Costs per tonne-kilometre</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,006	0,007
Variable costs	0,004	0,004
Staff costs	0,006	0,011
Mode-specific costs	0,000	0,001
General operating costs	0,001	0,000
Total costs per tonkm	0,017	0,023
<b>Costs per tonne per hour</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,048	0,050
Variable costs	0,027	0,033
Staff costs	0,046	0,079
Mode-specific costs	0,004	0,006
General operating costs	0,004	0,004
Total costs per tonne per hour	0,129	0,171
<b>(Un)loading and waiting</b>	<b>Metals</b>	<b>Containers</b>
Loading: costs per hour	95,04	98,80
Unloading: costs per hour	95,04	98,80
Waiting: cost per hour	95,04	98,80



Table A.4. Cost figures for 2018 for **push barges** for the commodity groups: agricultural and food products (agri); coal, brown coal and cokes (coal); ores in euros (€).

<b>Absolute costs</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>
Fixed costs	1.035.993	1.035.993	1.035.993
Variable costs	1.707.629	1.707.629	1.707.629
Staff costs	689.973	689.973	689.973
Mode-specific costs	95.858	95.858	95.858
General operating costs	189.817	189.817	189.817
Total annual costs	3.719.270	3.719.270	3.719.270
<b>Costs per kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>
Fixed costs	9,12	9,53	9,41
Variable costs	15,03	15,71	15,52
Staff costs	6,07	6,35	6,27
Mode-specific costs	0,84	0,88	0,87
General operating costs	1,67	1,75	1,72
Total costs per km	32,75	34,23	33,80
<b>Costs per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>
Fixed costs	128,47	128,47	128,47
Variable costs	211,76	211,76	211,76
Staff costs	85,56	85,56	85,56
Mode-specific costs	11,89	11,89	11,89
General operating costs	23,54	23,54	23,54
Total costs per hour	461,22	461,22	461,22
<b>Costs per tonne-kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>
Fixed costs	0,003	0,002	0,002
Variable costs	0,005	0,004	0,004
Staff costs	0,002	0,001	0,002
Mode-specific costs	0,000	0,000	0,000
General operating costs	0,001	0,000	0,000
Total costs per tonkm	0,011	0,008	0,009
<b>Costs per tonne per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>
Fixed costs	0,043	0,030	0,033
Variable costs	0,072	0,049	0,054
Staff costs	0,029	0,020	0,022
Mode-specific costs	0,004	0,003	0,003
General operating costs	0,008	0,005	0,006
Total costs per tonne per hour	0,156	0,106	0,117
<b>(Un)loading and waiting</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>
Loading: costs per hour	237,57	237,57	237,57
Unloading: costs per hour	237,57	237,57	237,57
Waiting: cost per hour	237,57	237,57	237,57



## Appendix B. Data road transport

Table B.1. Cost figures for 2018 for **trucks** for the commodity groups: agricultural and food products (agri); salt, sand, gravel and clay (salt); miscellaneous goods (misc) in euros (€).

<b>Absolute costs</b>	<b>Agri</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	7.999	7.999	7.695
Variable costs	44.691	40.628	39.284
Staff costs	62.706	62.706	71.210
Mode-specific costs	373	373	373
General operating costs	18.569	17.913	19.003
Total annual costs	134.338	129.619	137.566
<b>Costs per kilometre</b>	<b>Agri</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	0,15	0,16	0,10
Variable costs	0,81	0,81	0,50
Staff costs	1,14	1,25	0,91
Mode-specific costs	0,01	0,01	0,00
General operating costs	0,34	0,36	0,24
Total costs per km	2,44	2,59	1,76
<b>Costs per hour</b>	<b>Agri</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	3,33	3,33	2,98
Variable costs	18,62	16,93	15,20
Staff costs	26,13	26,13	27,55
Mode-specific costs	0,16	0,16	0,14
General operating costs	7,74	7,46	7,35
Total costs per hour	55,97	54,01	53,22
<b>Costs per tonne-kilometre</b>	<b>Agri</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	0,027	0,019	0,019
Variable costs	0,150	0,098	0,099
Staff costs	0,211	0,151	0,180
Mode-specific costs	0,001	0,001	0,001
General operating costs	0,062	0,043	0,048
Total costs per tonkm	0,452	0,312	0,348
<b>Costs per tonne per hour</b>	<b>Agri</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	0,62	0,40	0,59
Variable costs	3,44	2,03	3,00
Staff costs	4,83	3,14	5,43
Mode-specific costs	0,03	0,02	0,03
General operating costs	1,43	0,90	1,45
Total costs per tonne per hour	10,35	6,49	10,50
<b>(Un)loading and waiting</b>	<b>Agri</b>	<b>Salt</b>	<b>Misc</b>
Loading: costs per hour	37,20	36,92	37,88
Unloading: costs per hour	37,20	36,92	37,88
Waiting: cost per hour	37,20	36,92	37,88



Table B.2. Cost figures for 2018 for **truck + trailers** for the commodity groups: salt, sand, gravel and clay (salt); miscellaneous goods (misc) in euros (€).

<b>Absolute costs</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	16.548	14.732
Variable costs	41.510	51.500
Staff costs	66.714	71.210
Mode-specific costs	1.242	930
General operating costs	20.199	22.192
Total annual costs	146.214	160.565
<b>Costs per kilometre</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	0,30	0,19
Variable costs	0,75	0,66
Staff costs	1,21	0,91
Mode-specific costs	0,02	0,01
General operating costs	0,37	0,28
Total costs per km	2,66	2,06
<b>Costs per hour</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	6,90	5,70
Variable costs	17,30	19,92
Staff costs	27,80	27,55
Mode-specific costs	0,52	0,36
General operating costs	8,42	8,58
Total costs per hour	60,92	62,11
<b>Costs per tonne-kilometre</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	0,026	0,017
Variable costs	0,065	0,060
Staff costs	0,104	0,084
Mode-specific costs	0,002	0,001
General operating costs	0,032	0,026
Total costs per tonkm	0,228	0,189
<b>Costs per tonne per hour</b>	<b>Salt</b>	<b>Misc</b>
Fixed costs	0,59	0,52
Variable costs	1,48	1,82
Staff costs	2,39	2,52
Mode-specific costs	0,04	0,03
General operating costs	0,72	0,79
Total costs per tonne per hour	5,23	5,69
<b>(Un)loading and waiting</b>	<b>Salt</b>	<b>Misc</b>
Loading: costs per hour	43,11	41,83
Unloading: costs per hour	43,11	41,83
Waiting: cost per hour	43,11	41,83



Table B.3. Cost figures for 2018 for **tractor + trailers** for the commodity groups: chemical; miscellaneous goods (misc); base metals and metal products (metals); containers in euros (€).

<b>Absolute costs</b>	<b>Chemical</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	23.759	15.381	15.511	12.878
Variable costs	70.898	48.681	55.010	59.806
Staff costs	72.725	71.210	71.210	71.210
Mode-specific costs	1.368	930	930	932
General operating costs	26.235	21.843	22.888	14.967
Total annual costs	194.986	158.045	165.550	159.794
<b>Costs per kilometre</b>	<b>Chemical</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,22	0,20	0,17	0,12
Variable costs	0,64	0,62	0,61	0,57
Staff costs	0,66	0,91	0,79	0,68
Mode-specific costs	0,01	0,01	0,01	0,01
General operating costs	0,24	0,28	0,25	0,14
Total costs per km	1,77	2,03	1,84	1,52
<b>Costs per hour</b>	<b>Chemical</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	9,00	5,95	6,00	4,98
Variable costs	26,86	18,83	21,28	23,14
Staff costs	27,55	27,55	27,55	27,55
Mode-specific costs	0,52	0,36	0,36	0,36
General operating costs	9,94	8,45	8,85	5,79
Total costs per hour	73,86	61,14	64,04	61,82
<b>Costs per tonne-kilometre</b>	<b>Chemical</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,016	0,015	0,012	0,009
Variable costs	0,046	0,047	0,044	0,043
Staff costs	0,047	0,069	0,057	0,051
Mode-specific costs	0,001	0,001	0,001	0,001
General operating costs	0,017	0,021	0,018	0,011
Total costs per tonkm	0,127	0,154	0,132	0,115
<b>Costs per tonne per hour</b>	<b>Chemical</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Fixed costs	0,65	0,45	0,43	0,38
Variable costs	1,93	1,43	1,53	1,75
Staff costs	1,98	2,09	1,98	2,09
Mode-specific costs	0,04	0,03	0,03	0,03
General operating costs	0,71	0,64	0,64	0,44
Total costs per tonne per hour	5,31	4,63	4,60	4,68
<b>(Un)loading and waiting</b>	<b>Chemical</b>	<b>Misc</b>	<b>Metals</b>	<b>Containers</b>
Loading: costs per hour	46,48	41,95	42,40	38,32
Unloading: costs per hour	46,48	41,95	42,40	38,32
Waiting: cost per hour	46,48	41,95	42,40	38,32



Table B.4. Cost figures for 2018 for **LZVs** for the commodity groups: chemical; miscellaneous goods (misc); containers in euros (€).

<b>Absolute costs</b>	<b>Chemical</b>	<b>Misc</b>	<b>Containers</b>
Fixed costs	34.000	17.753	14.806
Variable costs	73.679	55.230	70.330
Staff costs	74.103	72.725	74.103
Mode-specific costs	915	915	915
General operating costs	22.891	18.367	20.088
Total annual costs	205.588	164.990	180.242
<b>Costs per kilometre</b>	<b>Chemical</b>	<b>Misc</b>	<b>Containers</b>
Fixed costs	0,31	0,23	0,14
Variable costs	0,67	0,71	0,67
Staff costs	0,67	0,93	0,71
Mode-specific costs	0,01	0,01	0,01
General operating costs	0,21	0,24	0,19
Total costs per km	1,87	2,12	1,72
<b>Costs per hour</b>	<b>Chemical</b>	<b>Misc</b>	<b>Containers</b>
Fixed costs	12,64	6,72	5,50
Variable costs	27,39	20,92	26,15
Staff costs	27,55	27,55	27,55
Mode-specific costs	0,34	0,35	0,34
General operating costs	8,51	6,96	7,47
Total costs per hour	76,43	62,50	67,00
<b>Costs per tonne-kilometre</b>	<b>Chemical</b>	<b>Misc</b>	<b>Containers</b>
Fixed costs	0,016	0,012	0,008
Variable costs	0,034	0,038	0,036
Staff costs	0,034	0,050	0,038
Mode-specific costs	0,000	0,001	0,000
General operating costs	0,011	0,013	0,010
Total costs per tonkm	0,095	0,113	0,092
<b>Costs per tonne per hour</b>	<b>Chemical</b>	<b>Misc</b>	<b>Containers</b>
Fixed costs	0,64	0,36	0,30
Variable costs	1,39	1,12	1,40
Staff costs	1,40	1,48	1,48
Mode-specific costs	0,02	0,02	0,02
General operating costs	0,43	0,37	0,40
Total costs per tonne per hour	3,88	3,35	3,59
<b>(Un)loading and waiting</b>	<b>Chemical</b>	<b>Misc</b>	<b>Containers</b>
Loading: costs per hour	48,70	41,23	40,52
Unloading: costs per hour	48,70	41,23	40,52
Waiting: cost per hour	48,70	41,23	40,52



Table B.5. Cost figures for 2018 for **specialised vehicles**: delivery vans (vans); tractors solo (solo); special vehicles (special) in euros (€).

<b>Absolute costs</b>	<b>Vans</b>	<b>Solo</b>	<b>Special</b>
Fixed costs	1.634	9.737	8.858
Variable costs	10.993	35.201	54.254
Staff costs	64.488	71.210	94.567
Mode-specific costs	374	0	505
General operating costs	12.402	11.985	18.288
Total annual costs	89.892	128.133	176.473
<b>Costs per kilometre</b>	<b>Vans</b>	<b>Solo</b>	<b>Special</b>
Fixed costs	0,03	0,12	0,16
Variable costs	0,18	0,45	0,98
Staff costs	1,07	0,91	1,71
Mode-specific costs	0,01	0,00	0,01
General operating costs	0,21	0,15	0,33
Total costs per km	1,50	1,64	3,19
<b>Costs per hour</b>	<b>Vans</b>	<b>Solo</b>	<b>Special</b>
Fixed costs	0,63	3,77	3,59
Variable costs	4,25	13,62	21,99
Staff costs	24,95	27,55	38,33
Mode-specific costs	0,14	0,00	0,20
General operating costs	4,80	4,64	7,41
Total costs per hour	34,77	49,57	71,52
<b>Costs per tonne-kilometre</b>	<b>Vans</b>	<b>Solo</b>	<b>Special</b>
Fixed costs	0,13	n/a	n/a
Variable costs	0,87	n/a	n/a
Staff costs	5,12	n/a	n/a
Mode-specific costs	0,03	n/a	n/a
General operating costs	0,98	n/a	n/a
Total costs per tonkm	7,13	n/a	n/a
<b>Costs per tonne per hour</b>	<b>Vans</b>	<b>Solo</b>	<b>Special</b>
Fixed costs	3,01	n/a	n/a
Variable costs	20,25	n/a	n/a
Staff costs	118,80	n/a	n/a
Mode-specific costs	0,69	n/a	n/a
General operating costs	22,85	n/a	n/a
Total costs per tonne per hour	165,59	n/a	n/a
<b>(Un)loading and waiting</b>	<b>Vans</b>	<b>Solo</b>	<b>Special</b>
Loading: costs per hour	30,38	35,95	49,33
Unloading: costs per hour	30,38	35,95	49,33
Waiting: cost per hour	30,38	35,95	49,33



## Appendix C. Data railway transport

Table C.1. Cost figures for 2018 for **charter trains** for the commodity groups: agricultural and food products (agri); coal, brown coal and cokes; ores; salt, sand, gravel and clay (salt) in euros (€).

<b>Absolute costs</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	1.071.785	1.071.785	1.665.785	1.071.785
Variable costs	527.313	527.313	527.313	527.313
Staff costs	252.000	252.000	252.000	252.000
Mode-specific costs	543.738	708.188	736.788	708.188
General operating costs	359.225	383.893	477.283	383.893
Total annual costs	2.754.060	2.943.178	3.659.168	2.943.178
<b>Costs per kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	6,00	6,00	9,32	6,00
Variable costs	2,95	2,95	2,95	2,95
Staff costs	1,41	1,41	1,41	1,41
Mode-specific costs	3,04	3,96	4,12	3,96
General operating costs	2,01	2,15	2,67	2,15
Total costs per km	15,41	16,47	20,47	16,47
<b>Costs per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	297,72	297,72	462,72	297,72
Variable costs	146,48	146,48	146,48	146,48
Staff costs	70,00	70,00	70,00	70,00
Mode-specific costs	151,04	196,72	204,66	196,72
General operating costs	99,78	106,64	132,58	106,64
Total costs per hour	765,02	817,55	1016,44	817,55
<b>Costs per tonne-kilometre</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	0,007	0,004	0,004	0,004
Variable costs	0,003	0,002	0,001	0,002
Staff costs	0,002	0,001	0,001	0,001
Mode-specific costs	0,003	0,003	0,002	0,003
General operating costs	0,002	0,002	0,001	0,002
Total costs per tonkm	0,017	0,012	0,009	0,012
<b>Costs per tonne per hour</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Fixed costs	0,33	0,22	0,21	0,22
Variable costs	0,16	0,11	0,07	0,11
Staff costs	0,08	0,05	0,03	0,05
Mode-specific costs	0,17	0,15	0,09	0,15
General operating costs	0,11	0,08	0,06	0,08
Total costs per tonne per hour	0,85	0,61	0,47	0,61
<b>(Un)loading and waiting</b>	<b>Agri</b>	<b>Coal</b>	<b>Ores</b>	<b>Salt</b>
Loading: costs per hour	467,50	474,35	665,30	474,35
Unloading: costs per hour	467,50	474,35	665,30	474,35
Waiting: cost per hour	467,50	474,35	665,30	474,35



Table C.1. (continued) Cost figures for 2018 for **charter trains** for the commodity groups: crude oil and natural gas (oil); chemical; miscellaneous minerals (minerals); base metals and metal products (metals) in euros (€).

<b>Absolute costs</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Metals</b>
Fixed costs	1.075.800	1.075.800	1.071.785	959.365
Variable costs	527.313	527.313	527.313	527.313
Staff costs	252.000	252.000	252.000	252.000
Mode-specific costs	600.938	600.938	708.188	736.788
General operating costs	368.408	368.408	383.893	371.320
Total annual costs	2.824.458	2.824.458	2.943.178	2.846.785
<b>Costs per kilometre</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Metals</b>
Fixed costs	6,02	6,02	6,00	5,37
Variable costs	2,95	2,95	2,95	2,95
Staff costs	1,41	1,41	1,41	1,41
Mode-specific costs	3,36	3,36	3,96	4,12
General operating costs	2,06	2,06	2,15	2,08
Total costs per km	15,80	15,80	16,47	15,93
<b>Costs per hour</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Metals</b>
Fixed costs	298,83	298,83	297,72	266,49
Variable costs	146,48	146,48	146,48	146,48
Staff costs	70,00	70,00	70,00	70,00
Mode-specific costs	166,93	166,93	196,72	204,66
General operating costs	102,34	102,34	106,64	103,14
Total costs per hour	784,57	784,57	817,55	790,77
<b>Costs per tonne-kilometre</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Metals</b>
Fixed costs	0,007	0,007	0,004	0,004
Variable costs	0,003	0,003	0,002	0,002
Staff costs	0,002	0,002	0,001	0,001
Mode-specific costs	0,004	0,004	0,003	0,003
General operating costs	0,002	0,002	0,002	0,001
Total costs per tonkm	0,018	0,018	0,012	0,011
<b>Costs per tonne per hour</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Metals</b>
Fixed costs	0,33	0,33	0,22	0,18
Variable costs	0,16	0,16	0,11	0,10
Staff costs	0,08	0,08	0,05	0,05
Mode-specific costs	0,19	0,19	0,15	0,14
General operating costs	0,11	0,11	0,08	0,07
Total costs per tonne per hour	0,88	0,88	0,61	0,52
<b>(Un)loading and waiting</b>	<b>Oil</b>	<b>Chemical</b>	<b>Minerals</b>	<b>Metals</b>
Loading: costs per hour	471,17	471,17	474,35	439,63
Unloading: costs per hour	471,17	471,17	474,35	439,63
Waiting: cost per hour	471,17	471,17	474,35	439,63

\* Crude oil and natural gas.

\*\* Miscellaneous minerals.

\*\*\* Base metals and metal products.



Table C.2. Cost figures for 2018 for **wagon load trains** and **shuttle trains**, with respective commodity groups: miscellaneous goods and containers in euros (€).

<b>Absolute costs</b>	<b><i>Wagon load</i></b>	<b><i>Shuttle</i></b>
Fixed costs	1.771.440	944.911
Variable costs	1.619.313	527.313
Staff costs	601.440	252.000
Mode-specific costs	1.615.738	653.738
General operating costs	841.190	356.694
Total annual costs	6.449.120	2.734.655
<b>Costs per kilometre</b>	<b><i>Wagon load</i></b>	<b><i>Shuttle</i></b>
Fixed costs	9,91	5,29
Variable costs	9,06	2,95
Staff costs	3,36	1,41
Mode-specific costs	9,04	3,66
General operating costs	4,71	2,00
Total costs per km	36,08	15,30
<b>Costs per hour</b>	<b><i>Wagon load</i></b>	<b><i>Shuttle</i></b>
Fixed costs	492,07	262,48
Variable costs	449,81	146,48
Staff costs	167,07	70,00
Mode-specific costs	448,82	181,59
General operating costs	233,66	99,08
Total costs per hour	1791,42	759,63
<b>Costs per tonne-kilometre</b>	<b><i>Wagon load</i></b>	<b><i>Shuttle</i></b>
Fixed costs	0,011	0,006
Variable costs	0,010	0,003
Staff costs	0,004	0,002
Mode-specific costs	0,010	0,004
General operating costs	0,005	0,002
Total costs per tonkm	0,040	0,017
<b>Costs per tonne per hour</b>	<b><i>Wagon load</i></b>	<b><i>Shuttle</i></b>
Fixed costs	0,55	0,29
Variable costs	0,50	0,16
Staff costs	0,19	0,08
Mode-specific costs	0,50	0,20
General operating costs	0,26	0,11
Total costs per tonne per hour	2,00	0,85
<b>(Un)loading and waiting</b>	<b><i>Wagon load</i></b>	<b><i>Shuttle</i></b>
Loading: costs per hour	892,80	431,56
Unloading: costs per hour	892,80	431,56
Waiting: cost per hour	892,80	431,56



## Appendix D. Glossary and abbreviations

<b>Average tonnage (t)</b>	Average amount of freight carried by vehicle during one year, measured in tonnes.
<b>BasGoed</b>	Basismodel Goederenvervoer (van Rijkswaterstaat); Baseline model for freight transport (by RWS)
<b>BIVAS</b>	Binnenvaart Analyse Systeem; Inland Waterway Transport Analysis System
<b>BZW</b>	Belasting Zware Motorrijtuigen; Dutch tax on heavy goods vehicles
<b>Cargo type</b>	Freight categorization methodology used in this study; there are 4 main cargo types, each of which contains one or more commodity groups
<b>Carrying capacity (t)</b>	Maximum weight that a transport vehicle can, or is allowed to, carry and transport, measured in tonnes
<b>CBS</b>	Statistics Netherlands
<b>CFFT</b>	Cost Figures for Freight Transport
<b>CLA</b>	Collective Labour Agreement
<b>Commodity groups</b>	Freight categorization methodology used in this study; there are 10 commodity groups, in turn divided among 4 cargo types
<b>Cost per kilometre (€)</b>	Total annual costs / distance travelled (km)
<b>Cost per hour (€)</b>	Total annual costs / time in use (hr)
<b>Cost per tonne-kilometre (€)</b>	Total annual costs / (distance travelled (km) * average tonnage)
<b>Cost per ton per hour (€)</b>	Total annual costs / (time in use (hr) * average tonnage)
<b>Cost of waiting and (un)loading per hour (€)</b>	(Fixed costs + staff costs + general operating cost) / time in use (hr)
<b>Distance travelled (km)</b>	Total distance travelled by a transport vehicle in one year, measured in kilometres
<b>Distance travelled while loaded (%)</b>	Distance travelled while loaded with cargo (km) / total distance travelled (km)
<b>DLU</b>	Unit Load Device; a type of container specifically designed for cargo aircraft
<b>HGV</b>	Heavy goods vehicle; truck
<b>hr</b>	Hour
<b>hr/yr</b>	Hour per year
<b>IenW</b>	Ministerie van Infrastructuur en Waterstaat; Dutch Ministry of Infrastructure and Water Management
<b>KiM</b>	Kennisinstituut voor Mobiliteitsbeleid; Netherlands Institute for Transport Policy Analysis
<b>km</b>	Kilometre
<b>km/h</b>	Kilometres per hour
<b>km/yr</b>	Kilometres per year
<b>kn</b>	Knots (unit of speed for ships)
<b>Load factor</b>	Average tonnage / carrying capacity
<b>LZV</b>	Langere Zwaardere Vrachtautocombinatie; longer heavier truck configuration, alternatively: ecocombi



<b>MRB</b>	Motorrijtuigenbelasting; Dutch tax on motorised vehicles
<b>m</b>	Meter
<b>Navigation time (hr)</b>	Total time that a transport vehicle was travelling between two points in one year, measured in hours
<b>NM</b>	Nautical mile
<b>NIWO</b>	Nationale en Internationale Wegvervoer Organisatie; National and International Road Freight Transport Organisation
<b>RWS</b>	Rijkswaterstaat; Directorate-General for Public Works and Water Management
<b>SEE</b>	Steunpunt Economische Expertise; Support Centre for Economic Expertise
<b>SSY</b>	Simon Spence Young
<b>TEU</b>	Twenty Foot Equivalent Unit; the standardized shipping container
<b>Time in use (hr)</b>	Total time that a transport vehicle was used in one year, measured in hours. Note that usage does not solely denote navigation time, but also includes waiting, (un)loading etc.
<b>Time (un)loading (hr)</b>	Total time that a transport vehicle was being (un)loaded in one year, measured in hours
<b>Total annual cost (€)</b>	Fixed costs + variable costs + staff costs + mode-specific costs + general operating costs
<b>Tonne (t)</b>	Unit of measurement equivalent to 1000 kilograms
<b>Tonne-kilometre (tkm)</b>	Unit of measurement for transport performance; a tkm represents the transport of one tonne of freight over the distance of one kilometre by a transport vehicle
<b>Transport modes</b>	Inland waterway transport, road transport, maritime transport, railway transport, air transport
<b>yr</b>	Year
<b>Utilisation rate</b>	Occupancy rate / load factor



## Appendix E. Crewing regulations for inland waterway transport

Figure E.1. Crew regulations for motorized ships and push barge configurations in the Netherlands.

Groep	Bemanningsleden	Aantal bemanningsleden bij de exploitatiewijze A1, A2 of B en voor de uitrustingsstandaard S1 of S2					
		A1		A2		B	
		S1	S2	S1	S2	S1	S2
1 $L \leq 70$ m	schipper	1		2		2	2
	stuurman	-		-		-	-
	volmatroos	-		-		-	-
	matroos	1		-		1	-
	lichtmatroos	-		-		1 <sup>1)</sup>	2 <sup>1) 3)</sup>
2 $70 \text{ m} < L \leq 86$ m	schipper	1 of	1 1	2		2	2
	stuurman	-	- -	-		-	-
	volmatroos	1	- -	-		-	-
	matroos	-	1 1	-		2	1
	lichtmatroos	-	1 1	1 <sup>1)</sup>		-	1
3 $L > 86$ m	schipper	1 of	1 1	2	2	2 of	2 2
	stuurman	1	1 1	-	-	1	1 <sup>2)</sup>
	volmatroos	-	- -	-	-	-	-
	matroos	1	- -	1	-	2	1 1
	lichtmatroos	-	2 1	1 <sup>1)</sup>	2 <sup>1)</sup>	-	- 1

Source: Rijksoverheid, *Inland waterway transport Regulation; chapter 5 (2020)*: <https://wetten.overheid.nl/BWBR0025958/2020-01-01>



Figure E.2. Regulations for crewing types.

Groep	Bemanningsleden	Aantal bemanningsleden bij de exploitatiewijze A1, A2 of B en voor de uitrustingsstandaard S1 of S2							
		A1		A2		B			
		S1	S2	S1	S2	S1	S2	S1	S2
1 afmeting van het samenstel L ≤ 37 m B ≤ 15 m	schipper stuurman volmatroos matroos lichtmatroos machinist of matroos- motordrijver	1 - - 1 - -	- - - - -	2 - - - -	- - - -	2 - - 1 1 <sup>1)</sup> -	2 - - - 2 <sup>1)</sup> 3 <sup>1)</sup> -	- - - - -	- - - -
2 afmeting van het samenstel 37 m < L ≤ 86 m B ≤ 15 m	schipper stuurman volmatroos matroos lichtmatroos machinist of matroos- motordrijver	1 of - 1 - -	1 - - 1 1 -	1 - - - 1 <sup>1)</sup> -	2 - - - - -	- - - - -	2 - - 2 - -	2 - - 1 1 -	- - - -
3 duwboot + 1 duwbak met L > 86 m of afmeting van het samenstel 86 m < L ≤ 116,5 m B ≤ 15 m	schipper stuurman volmatroos matroos lichtmatroos machinist of matroos- motordrijver	1 of 1 - 1 - -	1 - - - 2 -	1 - - 1 1 <sup>1)</sup> -	2 - - - 2 <sup>1)</sup> -	2 - - - - -	2 of 12 <sup>1)</sup> - - 2 - -	2 1 - 1 1 -	- - - -
4 duwboot + 2 duwbakken*) motorschip + 1 duwbak*)	schipper stuurman volmatroos matroos lichtmatroos machinist of matroos- motordrijver	1 1 - 1 1 <sup>1)</sup> -	1 - - - 2 <sup>1)</sup> -	2 - - 2 1 <sup>1)</sup> -	2 - 1 - 2 <sup>1)</sup> -	2 of 12 <sup>1)</sup> - - 2 -	2 1 1 - 1 1	2 of 12 <sup>1)</sup> 1 - - - -	2 1 <sup>1)</sup> 1 -
5 duwboot + 3 of 4 duwbakken*) motorschip + 2 of 3 duwbakken*)	schipper stuurman volmatroos matroos lichtmatroos machinist of matroos- motordrijver	1 of 1 - - 2 - 1	1 - - 1 2 1 1	1 - - 2 1 <sup>1)</sup> 1	2 - - - 2 <sup>1)</sup> 1	2 of 12 <sup>1)</sup> - - 2 2 1	2 1 - - 2 2 1	2 of 12 <sup>1)</sup> 1 - - - 1 1	2 1 <sup>1)</sup> 1 1
6 duwboot + meer dan 4 duwbakken*)	schipper stuurman volmatroos matroos lichtmatroos machinist of matroos- motordrijver	1 of 1 - - 3 - 1	1 - 2 2 1 1	1 - 1 3 1 <sup>1)</sup> 1	2 - 1 1 2 <sup>1)</sup> 1	2 of 12 <sup>1)</sup> - - 3 3 1	2 1 1 - 1 <sup>1)</sup> 1	2 of 12 <sup>1)</sup> 1 - 3 1 1	2 1 <sup>1)</sup> 1 1



## Appendix F. Interview questions for railway freight transport operators

### Locomotieven

1. Welke locomotieven rijden het meest in NL (en kunnen over de grens)?
2. Hoeveel locomotieven per type trein?
  - a. Containertrein
  - b. Bulk trein
  - c. Wagonlading trein
3. Gemiddeld aantal kilometers per jaar per type trein?
  - a. Containertrein
  - b. Bulk trein
  - c. Wagonlading trein
4. Aantal effectieve uren per jaar per type trein (container, bulk, wagonlading)?
5. Aantal rijuren per jaar per type trein (container, bulk, wagonlading)?
6. Eventueel gemiddelde snelheid trein (ipv vr 5)?
7. Leasekosten per jaar per locomotief?
8. Gemiddelde totale onderhoudskosten per type locomotief per jaar?

### Wagons

1. In een bulk trein, welke lading zit daar het vaakst / meest in?
2. In een wagonlading trein, welke lading zit daar het vaakst / meest in?
3. Gemiddeld aantal wagons per type trein?
  - a. Containertrein
  - b. Bulk trein
  - c. Wagonlading trein
4. Kosten lease per wagon type?
  - a. Normale open wagon (E-type)
  - b. Stortwagon (F-type)
  - c. Stortwagon met dak (T-type)
  - d. Gesloten wagon (G-type)
  - e. Gesloten wagon met schuifwanden (H-type)
  - f. Platte wagon (K-type, R-type)
  - g. Containerdraagwagon (L-type, S-type)
  - h. Bulkwagon met lossing onder druk (U-type)
  - i. Koelwagon (I-type)
  - j. Ketelwagon (Z-type)
5. Gemiddelde tonnage van de lading per type trein (container, bulk, wagonlading)?
6. Gemiddelde totale onderhoudskosten per type wagon per jaar?

### Rangeren

1. Gemiddelde rangeerkosten per type trein per jaar?

### Personeel

1. Aantal machinisten per trein?
2. Ander personeel op goederentrein?
3. Kosten (incl. sociale lasten) machinist per jaar per type trein (indien sprake van andere soort machinist per treintype)?
4. Eventueel kosten machinist per uur per type trein (ipv vr 3)?
5. Eventueel aantal inzet uren per jaar (machinist) (ipv vr 3)?



**Brandstofverbruik**

1. Gemiddelde elektriciteitsverbruik / diesilverbruik per jaar per type trein?
2. Betaalde brandstofprijs per liter?

**Kosten infrastructuur**

1. Gebruiksvergoeding voor toegang op het spoor per jaar (totaal voor inzetgebieden van de trein) per type trein?

**Algemene kosten per jaar**

1. Wat zijn de overhead kosten (uitgedrukt in percentage van de totale kosten van een trein, of een vast bedrag gedeeld over het aantal gereden kilometers van alle treinen)?
2. Nog andere kostenposten?

