# Assessing the Costs and Benefits of a Speed Limit for Freight Trains During Night-Time Operations: A Generic Model for the Netherlands

by

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# Declaration

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Date: March 2020

## Abstract

Noise pollution is a severe issue for numerous individuals, especially when it occurs consistently and throughout the entire day. As a major source of emissions, transportation has long been in the focus of policy makers hoping to alleviate affected persons from negative effects on health and wellbeing. In such an attempt, the Dutch Ministry of Infrastructure and Water Management plans to reduce the maximum allowed speed for freight trains between 11pm and 7am to either 40 km/h or 60 km/h. In order to assess and compare the total economic advantages and disadvantages of such a policy, the Ministry commissioned a study to explore the resulting effects.

This research thesis therefore set out to answer the questions if and how much a nightly speed limit reduction for freight trains in the Netherlands will reduce the noise levels and influence the operations of these services. Distinguishing between three different production systems (block trains, wagonload trains and combined transport) and different transportation distances, it is found that operating costs will increase between 0.3% and 5.0%.

It is expected that as freight trains becomes more costly to operate, consignors will opt for transportation alternatives on roads and inland waterways. Thus, the second purpose of this study is to determine the demand behaviour and a potential modal shift in the Dutch rail freight market. In order to do so, 13 industry experts from railway operators, freight forwarders and consignors were interviewed. From these interviews, quantitative and qualitative indications were used to calculate price elasticities for rail freight services in the relevant market. These elasticities, again depending on the production system, the transport distance and the level of cost increase, vary between 0.1 and 2.6, which is consistent with previous research.

The final question to answer concerns the feasibility of a case study. In an economic cost-benefit analysis, this paper investigates a train line between the Dutch towns of Meteren and Boxtel. It is found that although noise and air pollutant emissions related to freight trains decrease, there are negative effects outweighing the benefits. During the time period from 2030 to 2040, total costs exceed the total benefits by around 3.73 €m (alternative 1, reduction to 40 km/h) and 1.35 €m in 2019 values. This corresponds to a benefit-cost ratio of 0.274 and 0.353 respectively.

This paper shows that a speed reduction does in deed reduce costs to society that stem from noise emitted by freight trains. However, this measure has side effects, as traffic volumes will shift to trucks and barges as the railway freight product becomes more and more unattractive. Operational cost increases and external costs (e.g. higher air pollution by trucks or higher probability of accidents) outweigh the benefits to society. Therefore, the author recommends to reject the suggested speed limit reduction for freight trains between 11pm and 7am in the Netherlands.

# Opsomming

Geraasbesoedeling is 'n ernstige probleem vir talle individue, veral as dit konstant deur die hele dag voorkom. Vervoer is een van die hoof bronne van emissies en beleidmakers fokus al lank daarop om diegene wat geraak word, te verlig van negatiewe gevolge vir hul gesondheid en welstand. In so 'n poging beplan die Nederlandse Ministerie van Infrastruktuur en Waterbestuur om die maksimum toegelate snelheid van goederetreine tussen 23:00 en 07:00 tot 40 km / h of 60 km / h te verminder. Ten einde die totale ekonomiese voor- en nadele van so 'n beleid te beoordeel en te vergelyk, het die Ministerie 'n ondersoek gelas om die gevolge daarvan te ondersoek.

Die doel van hierdie studie is om vas te stel of die nagtelike vermindering van die snelheid vir goederetreine in Nederland die geraasvlakke sal verlaag en om tebepaal wat die impak hiervan sal wees op die verskeie vragvervoerdienste. In hierdie studie word daar onderskei tussen drie verskillende produksiestelsels (blokkeer treine, waentrein en gekombineerde vervoer) asook verskillende vervoerafstande. Die studie toon dat bedryfskoste tussen 0,3% en 5,0% sal styg weens die vermindering in snelhede. Na verwagting, oorweeg versenders ander vervoeralternatiewe op paaie en binnelandse waterweë namate goederetreine duurder word.

Die tweede doel van hierdie studie is om die vraaggedrag en 'n moontlike modale verskuiwing in die Nederlandse spoorvragmark te bepaal. Om dit te kan doen, is 'n onderhoud met 13 kundiges in die bedryf van spoorweëoperateurs, vragversendings agente en versenders gevoer. Uit hierdie onderhoude is kwantitatiewe en kwalitatiewe aanduidings gebruik om pryselastisiteite vir spoorvragdienste in die betrokke mark te bereken. Afhangend van die produksiestelsel, die vervoerafstand en die kosteverhoging wissel hierdie elastisiteite tussen 0,1 en 2,6, wat in lyn is met vorige navorsing.

Laastens word die lewensvatbaarheid van 'n gevallestudie beantwoord deur n ekonomiese koste-voordeel-analise vir ‘n treinlyn tussen die Nederlandse gemeentes Meteren en Boxtel te ondersoek. ‘n Nagtelike spoedbeperking van 40km/h en 60km/h vir vragvervoer word gesien as alternatiewe om die geraasbesoedeling te verminder. Uitsette toon dat die uitstoot van geraas en lugbesoedeling wat met goederetreine verband hou verminder, maar dat dit nie die kostes van die alternatiewe oorskrei nie. Gedurende die periode van 2030 tot 2040 oorskry die totale koste die totale voordele met ongeveer 3,73 € m (alternatief 1, vermindering tot 40 km / h) en 1,35 € m in 2019-waardes met n voordeel-koste-verhouding van onderskeidelik 0.274 en 0.353.

Hierdie artikel toon dat 'n spoedvermindering in akte die koste vir die samelewing verminder as gevolg van geraas deur goederetreine. Hierdie maatreël het egter newe-effekte, aangesien verkeersvolumes na vragmotors en skepe verskuif namate die spoorwegproduk meer onaantreklik word. Die verhoging in bedryfskoste en eksterne koste (bv. Hoër lugbesoedeling deur vragmotors of groter waarskynlikheid van ongelukke) weeg swaarder as die voordele vir die samelewing. Daarom beveel die skrywer aan om die

voorgestelde vermindering van die snelheidsbeperking vir goederetreine tussen 23:00 en 07:00 in Nederland te verwerp.

## Acknowledgements

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## Abbreviations

| | | |
|---|---|---|
| B/C-Ratio | - | Benefit-Cost Ratio |
| CBA | - | Cost-Benefit Analysis |
| $CO_2$ | - | Carbon Dioxide |
| DB | - | Deutsche Bahn |
| EEA | - | European Environment Agency |
| EU | - | European Union |
| EC | - | European Commission |
| FBS | - | Fahrplanbearbeitungssystem (German for timetable processing system) |
| FRA | - | Federal Railroad Administration |
| GDP | - | Gross Domestic Product |
| HGV | - | Heavy Goods Vehicle |
| HSR | - | High-Speed Rail |
| NDI | - | Noise Depreciation Index |
| NS | - | Nederlandse Spoorwegen (state-owned Dutch Railway company) |
| $NO_x$ | - | Nitrous Oxides |
| NPV | - | Net Present Value |
| p-hr | - | person-hour |
| pkm | - | passenger kilometre |
| PM | - | Particular Matter |
| SBB | - | Schweizer Bundesbahn (Swiss National Railways) |
| $SO_x$ | - | Sulphur Oxides |
| TEU | - | Twenty-Foot Equivalent Unit |
| tkm | - | tonne kilometre |
| USA | - | United States of America |
| VAT | - | Value-added tax |
| VOC | - | volatile organic compounds |
| VoT | - | Value of Time |
| vkm | - | vehicle kilometre |
| WtP | - | Willingness-to-Pay |
| FENOCO | - | Ferrocarriles del Norte de Colombia S.A. |

## 1. Introduction

Transporting cargo by rail is older than any passenger service, with the first track-based lorry transport systems reaching back to ancient Egypt. Especially in the context of mining and large-scale construction sites, wooden tracks were used throughout the centuries to move heavy, bulky goods over growing distances. In 1767, the first iron cast rails were produced for the ironworks Coalbrookdale, England (Jänsch & Siegmann, 2008). At first, human muscle power and horses drew the carts; with the industrial revolution, Watt's invention of the steam machine and the first machine-powered locomotives meant that ever-larger distances could be covered with ever-heavier loads. Later, trains played an important role in the conquest of entire continents. In the United States of America, for example, almost 200,000 miles of tracks were in operation by the end of the 19$^{th}$ century, employing 1.8 million people by 1917 (Association of American Railways, 2018).

The benefits of rail transport are indisputable and its importance has been proven over the centuries. Railways can transport heavier loads than other land-based modes, they cover longer distances more efficiently and thus enable trade between remote regions. However, there are some major negative aspects associated with this mode. From a competition perspective, rail transport suffers from its prerequisite of an inflexible infrastructure (including for example tracks, electrification, signalling and slot allocation) and high investment costs, which make it almost impossible for private companies to establish, except for small sections on own premises to connect to main lines. From a societal perspective, trains, like any other form of transport, have a negative impact on the quality of lives of non-users, especially when noise is concerned. According to the European Environment Agency (EEA, 2014, p.20), around 14 million people in the European Union (EU) are estimated to suffer from excessive noise pollution caused by railways – a number which probably grew over the last five years. The impact on people's health, reaching from a simple feeling of discomfort and fatigue to stress responses, insomnia, emotional instability, cardiovascular problems and impaired hearing as far as premature death (European Environment Agency, 2014), has been investigated intensively. As a consequence, many stakeholders demand a reduction in noise levels, following different approaches. These include physical methods, such as the erection of noise deflection walls, better sound insulation for housing structures, track surface grinding or improved noise-reducing wheels and brakes on the trains. On the operational level, a limit on the number of trains allowed to pass or even complete night-time bans were considered. However, day-time rail track capacities are already nearly depleted in the Netherlands, which forces operators to shift to the night in the first place, while daytime operations would generally be preferred. As a consequence, a night-time ban would lead to the cancellation of the services altogether. Thus, another option is limiting the maximum allowed speed for trains, thereby reducing the noise emission caused by both engines and wheels.

In the Netherlands, such a speed limit is being considered for the night time operations in order to better protect the population from night-time noise burdens in the proximity of railway lines, especially where freight trains are passing.

The railway freight traffic in the Netherlands is dominated by transportation of seaborne goods transiting the country on the way between the Ports of Rotterdam and, to a lesser extent, Amsterdam and the European hinterland, especially Germany, Switzerland, Italy, Poland, Austria and the Czech Republic. Thus, quite big amounts of cargo cross the country around the clock and local residents have repeatedly complained about noise pollution creating significant public attention. Therefore, the Dutch Ministry of Infrastructure and Water Management has tasked ProRail B.V., the Dutch government's agency for managing the country's railway infrastructure, to investigate these noise effects and the possibility of reducing them by implementing a speed limit reduction during the night time between 11pm and 7am, a strategy that is called "differentiated driving". A pilot run for a speed limit reduction was voted by the Dutch House of Representatives to take place in the third quarter of 2019, however no specific schedule has been agreed on yet. The scope of this trial is the 32km-long track between Meteren and Boxtel and all freight trains passing this segment between 11pm and 7am will have to reduce their speed to a maximum of 40km/h or 60km/h (this decision is yet to be made by the ministry), regardless of type or weight. Passenger trains driving on this section will not have to reduce their speed even if they operate during the indicated hours. No specific aim in terms of a noise-level reduction has been communicated, the trial is intended to demonstrate the potential that such a measure actually has.

Intuitively, a speed limit reduction will reduce the attractiveness of railway as a mode, as the passage takes longer and the cargo is unavailable and unproductive for a longer time, which will lead to railway freight users choosing other options instead. While the European Union has started different initiatives to divert more and more freight from road to rail (e.g. by harmonising national legislation or by funding infrastructure)[1], the Dutch plans would counteract these efforts. Therefore, to explore whether the benefits of a noise reduction justify the additional system costs, ProRail B.V. has commissioned a study to investigate the general economic impacts of such an undertaking. The requested deliverable is a generic spreadsheet-based model that can be applied to assess the economic effects of slower driving on a national level, including financial effects for

[1] Compare, for example, the Shift-2-Rail initiative (https://ec.europa.eu/transport/modes/rail/shift2rail_en) or the ERTMS (European Rail Traffic Management System) program (https://ec.europa.eu/transport/modes/rail/ertms_en)

rail, truck and barge operators, as well as impacts on non-users coming from changes in externalities such as noise, air pollution or accidents due to a shift from rail to road or barge transport. Furthermore, an economic cost-benefit analysis of the pilot on the Meteren – Boxtel section is part of the scope, where operational and external cost implications are compared to the noise reduction benefits.

The first sections of this study will outline the research area and define its scope. Clear research questions will be formulated as a result of section 3. In section 4, previous research is presented in a literature review. This serves to create an understanding of the methodology used in cost-benefit analyses as well as to familiarize the reader with the subject of transportation externalities and their valuation. As a result, key components used to evaluate different transport modes are identified and described. These results will then be used within the scope of this study. Section 5 describes the railway freight system in the Netherlands, detailing the different production systems on the supply side and the demand side's requirements. After a chapter explaining the methodology applied in this research, three parts on the original research follow. Part 1, in section 7, elaborates on the effects of a speed limit reduction on freight train operations in the Netherlands. Part 2, in section 8, presents the resulting effects on demand in the Dutch rail freight market as determined in the expert interviews. Part 3, in section 9, delivers a comprehensive economic cost-benefit analysis of the Meteren-Boxtel case study. Finally, limitations and recommendations for future research are discussed before section 11 concludes the study.

## 2. Purpose of this Study

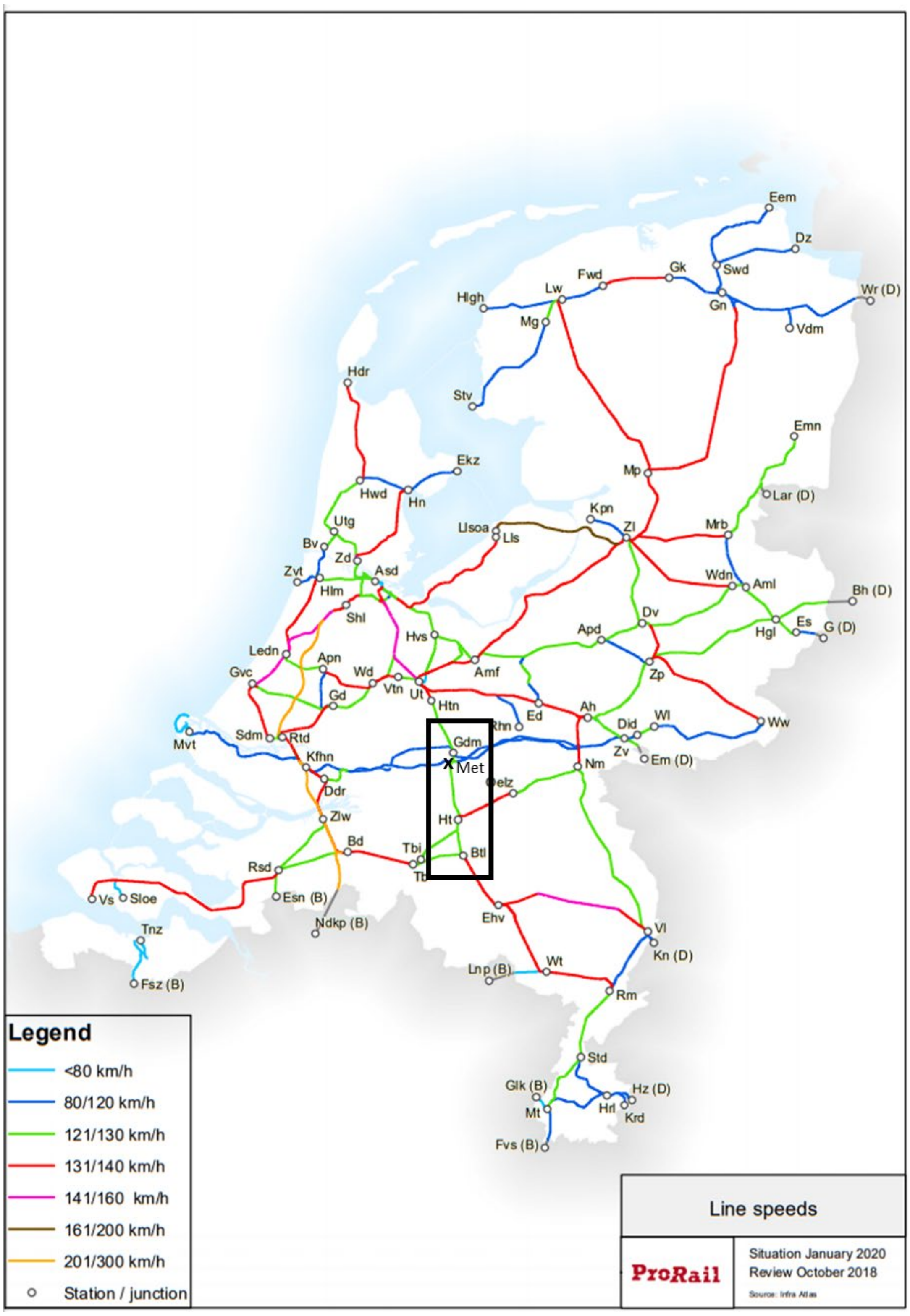


*Figure 1: Railway Route Network in the Netherlands with Line Speeds*
*Source: ProRail B.V.(2018a, p.167)*

Figure 1 shows the Dutch railway network and the Meteren – Boxtel (abbreviated as Met and Btl on the map) segment. The Dutch harbours connect with Eastern and Southern European destinations via the three border crossings into Germany at Venlo – Kaldenkirchen (Vl-Kn), Zevenaar – Emmerich (Zv-Em) and towards Bad Bentheim (Bh). The pilot segment is in the central part of the Netherlands and sees significant transit traffic between East and West and North and South, especially on those harbour-hinterland routes. As depicted in Figure 2, the European rail freight corridors 1 (Rhine-Alpine) and 8 (North Sea-Baltic) pass through Meteren, which shows the significance of the proposed route on the continental level[2].

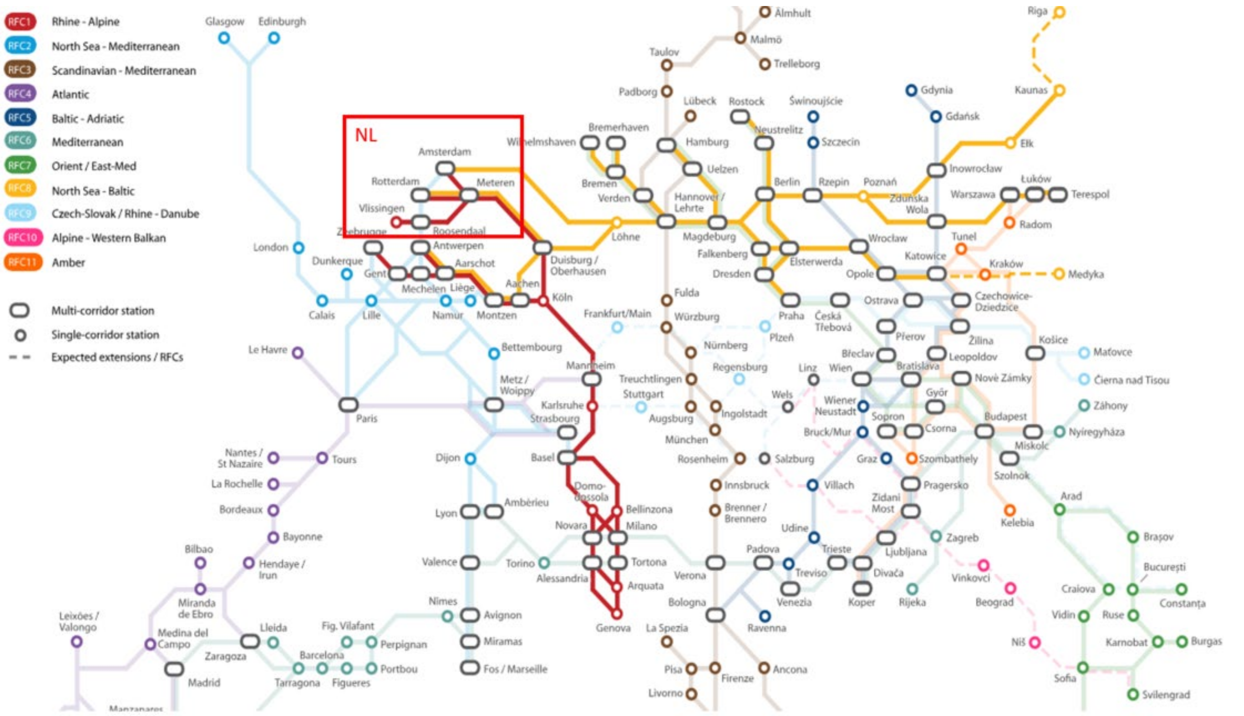


*Figure 2: European Rail Freight Corridors*
*Source: Rail Net Europe, http://www.rne.eu/rail-freight-corridors/rail-freight-corridors-general-information/*

This study seeks to investigate the effects of a speed limit as mentioned before. Social improvements are expected to arise from generally lower noise levels in the proximity of the railway line and a lower number of people affected by noise pollution. Using the concepts from economic cost-benefit analyses, this study seeks to identify and valuate the benefits and costs resulting from such a measure. Some drawbacks are expected to come hand in hand with these improvements, including, but not limited to, higher operational costs for the rail operators, loss of economic efficiency, a productivity loss and a shift of traffic to other modes, which might have different negative effects.

The shippers' sensitivity towards these operational changes is of special interest, especially with respect to increasing shipping times and costs. Therefore, the study tries to determine elasticities

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[2] EU regulation 913/2010 established rail freight corridors with the purpose of promoting rail freight transport by improving its reliability, cost efficiency and quality. Nine corridors were formed along major European transport axes to promote competitiveness.

between rail freight and its competing modes and estimate the transfer of current rail traffic to roads and inland waterways. While the term "costs" is frequently only associated with financial cash flows, the scope of this study also includes the relevant non-monetary, social costs and benefits. These are so-called externalities, i.e. detrimental effects on life that society as a whole faces as a consequence of a certain situation. In the context of transport, the most prominent of such costs are noise emissions, air pollution, accident costs or time loss due to congestion. In order to account for these theoretical costs, there are different methods to assign a monetary value to them and include them in the analysis.

Furthermore, investigations into technical and legal feasibility of the differentiated driving proposal have been awarded by ProRail to other consulting firms. While these are within the scope of the project, they are not included in the thesis at hand. This study intends to deliver a fact-based analysis and thereby support the decision-making process for the Dutch Ministry for Infrastructure and Water Management.

## 3. Research Questions

From the situation explained above, the study tries to answer the following research questions as a consequence of the effort to reduce the noise disturbance:

- What are the costs and benefits of a speed limit reduction for freight trains in the Netherlands during night-time operations?

Sub-Questions:

1) What are the operational effects and the cost implications of a speed limit reduction on the railway freight operators?
2) What are the demand effects, i.e. the elasticities, between costs of rail transportation and road and waterway transportation in the Netherlands?
   a. w.r.t. type of operations (three types: combined transport, block trains, wagonload trains)
   b. w.r.t. distances (short, middle, long)
3) What is the impact of the expected modal shift and speed reduction on financial and social costs of freight transportation by rail, waterway and by road transport?

These research questions will be answered in the course of the study. Sub-question 1 is discussed in section 7, sub-question 2 in section 8 and sub-question 3 in section 9.

# 4. Literature Review

This section supplies the reader with an overview of existing studies on the economic effects of railway operations. This includes both the evaluation criteria and the methods applied in these studies. The overview is complemented by official guidelines issued by acknowledged institutions, such as the European Commission (EC), national ministries or research centres.
The purpose of this section is to identify key components of financial and social benefits and costs relevant for the analysis and to choose the method to calculate them. As the suggested reduction of travelling speed is an operational change rather than a large investment, the intention of looking at other cost-benefit analyses is to compare the handling of externalities. Initial investment costs that are typical for new transport infrastructure projects are not relevant in this context.
Additionally, the research on elasticities between the modes in the freight transportation sector is covered. The aim is to identify findings on the subject as well as the methodology applied.
All three sections 4.1, 4.2 and 4.3 show that there is no single standard for any of the respective topics. The parameters selected for the calculations in this study will thus be introduced in the respective context, i.e. in section 7 for railway operating cost rates and in section 10 for other operating costs and external effects.

## 4.1. Evaluation Criteria in Existing Studies on Railway Operations

At the beginning of the section, different studies are presented with respect to the criteria used to assess the respective subject. Due to the availability, the focus is on cost-benefit analyses with respect to different railway projects. As there are hardly any studies investigating the introduction of a railway speed limit, only a short section on this will follow.

### 4.1.1. Existing Studies on Railway Cost-Benefit-Analysis

The research landscape with respect to rail projects is dominated by studies on high-speed rail connections. Although the construction of high-speed lines constitutes a completely different scenario, it is still worthwhile to see what costs and benefits are included in these studies.
A study on a proposed high-speed rail line linking San Francisco and Los Angeles in the United States was conducted by Kockelman in 1994. Comparing the rail line with existing flight connections and road trips, valued parameters are fare revenues, the consumer surplus (i.e. an estimation of what riders perceive to be their personal gain from using rail), avoided road accident

costs and reduced air pollution. Further effects, such as noise emission reduction, land use deterioration, investment attraction or employment effects are mentioned, but not calculated.

Some 20 years later, the California high-speed rail authorities commissioned a full business plan for a system of HSR lines connecting the San Francisco Bay Area to the Los Angeles Basin. Included in this business plan is a comprehensive economic CBA evaluating the project. A considerable effort was made to monetarily evaluate the benefits coming from less highway traffic, the main target of the railway line. Accordingly, lower vehicle operating costs (mainly fuel, maintenance and overhaul) and road fatalities played a major role, but also emissions (carbon dioxide ($CO_2$) and non-$CO_2$) and noise were of importance. Furthermore, travel time savings in combination with increased reliability expectations were identified as the single biggest benefit in monetary terms. One item that is excluded is fare revenues for the proposed HSR line, as "fares are an economic transfer from users to the HSR operator. Because they are a pecuniary transfer, they represent neither an economic benefit nor an economic cost of the project" (California High-Speed Rail Authority, 2014: 21). However, according to the European Union's "Guide to Cost-Benefit Analysis of Investment Projects" (2014), such revenues are part of the producers' surplus and have to be accounted for in an economic analysis. As will be pointed out in section 8, freight rates are highly competitive in the European market. Thus, it can be assumed that modal changes, if they occur, do not significantly affect the price per tonne kilometre. Therefore, payments from customers to rail or truck operators are considered as sticky and are not within the scope of this study.

De Rus & Inglada (1997) conducted an ex-post cost-benefit-analysis of the Madrid-Seville high-speed rail corridor over a 40-year span. While they find the project to be economically not justified, it is interesting to notice that noise and air pollution are not quantified in the analysis. It is acknowledged that trains emit lower amounts of noise and other pollutants, but they are neglected based on the argument that they do not fully disappear but rather shift from other modes. With respect to the environment, only reduced congestion costs and road accidents are calculated in the study. Apart from that, differences in travel times and operating costs compared with competing modes are considered. The impact of rail freight transport was not considered.

Likewise, a quite simple analysis is done by Fröidh (2014), rather coming from an engineering-themed background. He tries to maximize benefits under different design speeds and track construction methods for a proposed high-speed network in Sweden. While the investment cost calculation is quite technical, the calculation of economic benefits is rather basic and focuses on saved maintenance and operating costs, travel time gains and revenues from induced traffic. Environmental issues, such as any saved emissions from other modes, are mentioned but not quantified individually. Only a marginal externality rate per passenger is applied which was obtained from the Swedish Transport Administration.

In the Asian context, Tao et al. analyse costs and benefits of an approved HSR linking Hong Kong's Kowloon station with Guangzhou in mainland China. Main contributors on the benefit side were ticket revenues, travel time savings including reliability improvements, the reduction of air pollution ($CO_2$ and nitrous oxides ($NO_x$)), and safety gains. A lump sum rate per passenger kilometre for external costs caused by the HSR operations is calculated, covering the negative externalities associated with land resumption, barrier effects, visual intrusion, noise, air pollution and contribution to global warming. However, avoided noise from decreasing car use is not accounted for. The sensitivity analysis concluding their report shows that rolling stock operating and maintenance costs have a large impact on the overall project profitability. On the benefit side, the number of users is important for the travel time savings and thus for social benefits. Environmental effects are less considered.

Shifting away from the high-speed situation, Wang et al. suggested to upgrade the commuter train situation in Dhaka, Bangladesh, based on different alternatives. These are increasing train speed by upgrading the tracks, purchasing new diesel locomotives and building a second track to increase the capacity. The main criteria to assess the impact of the initial investment are travel time gains, fare revenues, reduction of automobiles' pollutant emissions and reduction of road accidents with the resulting loss of life.

A slightly different approach is chosen by Cascajo (2005), investigating seven different completed European urban rail projects. Firstly, an ex-post perspective is taken. In order to focus on the sustainability of each of the seven cases, the projects are evaluated long after their completion. Secondly, as in her words a cost-benefit-analysis is strictly financial and social issues could not be included due to the lack of a price tag, she conducts a multi-criteria analysis. The assessment criteria are assigned a normalized social utility factor and then compared to a scenario in which the investment had not taken place. The criteria are quite numerous, including economic efficiency (the difference between fare revenues and operating costs), travel time reduction, employment generation, economic growth in terms of GDP, social equity, increase of use of public transport, urban regeneration, air pollution, noise emissions, contribution to the greenhouse effect, and accident costs accounting for operational safety. Although no monetary values are presented, the results show that the presence of railway systems contributes (to a differing degree) to economic development, social well-being and environmental alleviation by reducing noise levels and other emissions.

Gonzales-Feliu (2014) points out that benefits are mainly generated by usage fees, shorter transport distances and overall time gains. Further improvements are less greenhouse gas emissions ($CO_2$) and other, not specified pollutants. He also mentions the reduction of congestion and noise exposure, however without monetarising them.

There are also academic and real project studies on rail freight operations, mostly related to infrastructure extension programmes. The proposed rail interchange in Connell, Washington, USA, is intended to improve the transit times for trains connecting between the BNSF main rail line and the Columbia Basin Railroad, as the existing infrastructure is outdated and easily congested. The benefits included in this CBA are reduced transportations costs for the shippers, reduced fuel consumption, lower maintenance costs for nearby highways, reduced $CO_2$ emissions due to lower truck vehicle miles, and improved road safety. Changing noise levels and air pollution connected to train operations are not included in the study, although reduced congestion in the interchange could attract more traffic on the route.

Goldsmith and Schwoerer (2011) created a cost benefit analysis for the Barge Berths and Rail Extension Project at the Port of Anchorage, Alaska, USA. In this project, the docks at the port are to be enhanced and connected to the existing railway line. Today, the missing link is bridged by truck traffic, which would be completely avoided if the new link was built. This is intended to generate advantages with respect to time and ease of operations. Furthermore, truck fuel consumption and its emissions are reduced. A big emphasis is put on the shifting transportation routes, especially with respect to barge traffic and access to Western Alaska. However, no monetary value is assigned to reduced accidents on highways as a result of traffic streams being diverted to the barges. Likewise, even enhanced military preparedness and earthquake response capabilities are mentioned as benefits.

A similar project evaluation comes from the Port of Seattle, Washington, USA. The CBA has been commissioned to evaluate the upgrading of the port terminal facilities, allowing the accommodation of larger ships. This measure is supposed to convince shippers to use Seattle of their port of choice when shipping from and to the Asian markets. This would result in shorter inland transportation, both for railway and truck transportation, and thus in lower operating costs. Along with it comes reduced maintenance costs for highways and fewer costly road accidents. With respect to air pollution, a table is provided detailing the saved emissions of $CO_2$, $NO_x$, particulate matter (PM), sulphur oxides ($SO_x$) and volatile organic compounds (VOC). Noise is not mentioned in the study.

Sediqi (2017) researched a very different scenario. For a long time, the railway line crossing the border between Afghanistan and Uzbekistan was closed for political reasons. After its re-opening in 2011, trade volumes increased in the northern part of Afghanistan. The central subject of the investigation was the consumer surplus, i.e. the gains from trade, in this region, quantified by the dropping prices for freight consignments and the increased trade volume. The competing modes for cross-border trade are river barges and trucks, so that more benefits were achieved due to lower operating costs of rail as opposed to the other modes. Like potential gains from shorter transportation times, social costs regarding noise, pollution or congestion have not been considered.

Table 1 summarizes the criteria that were used to assess the costs and benefits mentioned in the studies above.

*Table 1: Criteria for CBA*

| Nr | Author | Type | Operating Costs | Revenues | Maintenance | Travel Time (incl. Reliability) | Employment Generation | Economic Growth | Social Aspects (e.g. equity) | Air Pollution | Noise | Safety |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Cascajo (2005) | Pax | x | x | | x | x | x | x | x | x | x |
| 2 | de Rus & Inglada (1997) | Pax | x | x | | x | | x | | | | x |
| 3 | Kockelman (1994) | Pax | x | x | | x | o | o | o | x | o | x |
| 4 | California HSR Authority (2011) | Pax | x | o | | x | | o | o | x | x | x |
| 5 | Fröidh (2014) | Pax | x | x | x | x | | o | | | o | o |
| 6 | Tao et al. (2011) | Pax | x | x | x | x | | | | x | | x |
| 7 | Wang et al. (2014) | Pax | x | x | | x | | | | x | | x |
| 8 | Gonzales-Feliu (2014) | Freight | x | x | x | x | o | o | | x | o | o |
| 9 | The Beckett Group (2018) | Freight | x | | x | | | | o | | | x |
| 10 | Goldsmith, Schwoerer (2011) | Freight | x | | x | x | | x | o | x | | x |
| 11 | NWSA (2016) | Freight | x | | x | x | | | | x | | x |
| 12 | Sediqi (2017) | Freight | x | | | | | x | | | | |

*x = applied, o = mentioned but not applied, blank = not in the study*

Accordingly, operating cost and travel time are the criteria, which receive the most attention in cost-benefit analyses. Likewise, revenues and maintenance costs, external costs (air pollution, noise and safety) are frequently discussed, while there is less attention on economic growth, employment and social aspects. This is in line with different official CBA guidelines, as for example issued by the EC. This standard handbook provides guidance for project appraisals in general and adds sub-sections for different purposes, such as transport infrastructure, environmental improvements, energy infrastructure or research innovation projects. The transport section lists travel time, operating costs, accidents, noise, air pollution and climate change under the economic analysis section (maintenance qualifies as financial costs) and details how to calculate them (European Commission, 2014). The Federal Railroad Administration (FRA), part of the US Department of Transportation, also issued guidelines for conducting CBA. They recommend including benefits to users of the transportation system (in terms of time savings, reliability, convenience), safety benefits, environmental benefits (reduced emissions of $CO_2$, $NO_x$, $SO_x$, PM and VOC), and further other benefits, such as agglomeration economies and productivity, infrastructure resilience, noise pollution, liveability, or the improved opportunities that public transport brings to people with disabilities, the elderly, remote communities or low income groups (Federal Railroad Administration, 2016).

For the purpose of this work, the following variables will be taken into account for the evaluation of a speed reduction, equally for rail, road and inland waterway transport:

- Infrastructure maintenance
- Operating costs
- Noise
- Air pollutants
- Climate Change ($CO_2$)
- Congestion
- Accidents
- Transport time

### 4.1.2. Earlier Studies on the Limitation of Train Speed

Germany has implemented a ban of trucks already in 1956, prohibiting the commercial operation of vehicles exceeding 7.5 tons of gross weight on Sundays and holidays. This measure is mainly motivated by the protection of labour rights, but occasional bans have also been applied to temporarily improve urban air quality. For trains, such a ban or a speed limit does not exist. Consequently, there is hardly any publicly available information on the effects of a reduced speed limit in railway operations. One case is to be found in Colombia, where the federal courts ruled a night time ban for a line operated by Ferrocarriles del Norte de Colombia S.A. (FENOCO). Noise and dust emissions had driven the population into severe protests, which finally led to the court's curfew ruling in January 2015 (Reuters, 2015a). Consequently, the 226km-line with the primary purpose to transport coal from Colombia's mines to its seaports for further export, could not be operated between 10:30pm and 4:30am. However, the ban was lifted within the same year after FENOCO had complied with noise and emission reduction schemes (Reuters, 2015b). The mines linked to the railway produce more than half of Colombia's entire coal output and a night ban had severe impact on the country's exports. While there are no data available on how the curfew affected the economic situation or the residents' quality of life, it can be assumed that non-operational noise abatement measures (e.g. sound walls) and dust reduction modifications were the preferred choice over suspending operations altogether.

In a qualitative statement, the European Court of Auditors criticised the low speed of rail freight transport with no significant improvements over the last decade (2016). Therefore, it was less attractive compared to other modes, which contributed to "the poor performance of rail freight transport in terms of volume and modal share in the EU" (European Court of Auditors, 2016: 27).

Likewise, the Environment Protection Authority of South Australia accepts the advantages of rail-based transport acknowledging that it had a much better ecologic footprint than trucking. They continue by saying that "a curfew for the rail industry is not a feasible option. The rail industry transports products between all major capital cities, to market, port, suppliers, manufactures, small businesses and wholesalers, and to meet export and import timetables, freight must be able to be transported on a 24-hour basis" (Environment Protection Authority South Australia, 2018)

Lovett, Dick & Barkan (2016) provide a study that is very meaningful to this thesis, as it includes the relevant cost elements with respect to railway freight. They describe how to value freight delay costs resulting from railroad maintenance or upgrade works in the United States for the operators, the shippers and the public. Railroad costs concern crew, locomotives, fuel, railcars, and lading and result from longer equipment operating times. It must be noted that they find that some of these costs are semi-fixed, because new rolling stock has to be purchased once a certain threshold is crossed. Shippers' costs occur when the goods lose value during longer transport times or when higher transport costs must be accepted due to a modal shift. Public costs include locomotive emissions costs ($CO_2$, $NO_x$, PM) and waiting times at railway crossings, while for example noise is omitted.

There is, however, one study that deals with the economic effects of a proposed introduction of a speed limit to mitigate noise disturbance in Germany, which was commissioned by three industry associations[3]. The authors consider schedule data from different railway segments and extrapolate them to the national level. They find that a speed limit of 70 km/h at night will probably increase trip times by 24% and decrease the network capacity by 20% on average (Via Consulting and Development GmbH & Railistics GmbH, 2014). Based on these results, they estimate increased financial operating costs as a sum of locomotive, freight cars, labour and infrastructure access charges. Energy costs were treated as neutral under the assumption that while slower speeds reduce energy consumption, more frequent breaking and acceleration caused by the prioritization of passenger trains would at least equalize the savings. Additionally, and this was the most significant disadvantage, more rolling stock (locomotives and freight cars) had to be purchased because longer return trip times meant that scheduled departures could no longer

[3] Association of German Transport Companies (Verband Deutscher Verkehrsunternehmen (VDV)), Association of Rail Freight Car Owners in Germany (Verband der Güterwagenhalter in Deutschland (VPI)), and Federation of German Industries (Bundesverband der Deutschen Industrie (BDI))

be kept. The study lists only financial elements, as for example loss of revenues for infrastructure providers and railway operators or their increased operating costs are calculated.
The authors did point out that the amount of cargo no longer transported by rail due to the lost track capacity and increasing costs was equivalent to 5.2 million truckloads per year. These would be transferred to the road, thus increasing negative externalities even more. Even though none of the external effects were monetarized in this study, the recommendation was to reject the suggested speed limit reduction as it would have detrimental results for the rail freight system and road transport as well.

## 4.2. Methods Applied to Quantify the Criteria

This section creates an understanding of the methods used to quantify the criteria identified before, starting with the financial costs (operations and maintenance), followed by the social costs (value of time and congestion, noise, air pollution and climate change, accidents). The studies used in the previous section will be complemented by other literature, which might be more specific and thus better suited to explain the methods.
The cost calculation employed in the quantitative part of this study will be detailed at the specific section in chapters 7 and 10.

### 4.2.1. Infrastructure Maintenance Costs

Maintenance costs are relevant to any kind of infrastructure regardless of the mode. In order to keep the infrastructure in a good state of repair, continuous measures need to be taken in order to guarantee safe and reliable operations. Maintenance costs vary across the modes and also within the modes. In the railway context, for example, an electrified double-track line is much costlier to maintain than a non-electrified single-track line. With respect to CBA, maintenance costs are part of the financial analysis, as cash flows are involved. Thus, all projected cash flows related to future upkeep have to be included and benefits result from a possible reduction compared to a scenario where nothing is changed (European Commission, 2014). In the application handbook for its 2030 federal transport plan (Methodenhandbuch zum Bundesverkehrswegeplan 2030, 2015; from here on “BVWP handbook”), the German Ministry of Transport and Digital Infrastructure[4] suggests to estimate annual maintenance costs with a certain percentage of the initial investment costs. For rail infrastructure, the most important categories are signalling and communication, tracks and switches, electrification, track bed and support, bridges and tunnels. However, these percentage costs would not change in case of a speed reduction after the completion of the infrastructure. Lovett (2016) recommends using approximations based on industry data, without specifying any values. A possible solution is the allocation of a fraction of case-specific historic maintenance costs to single trains or events. De Rus & Inglada (1997), too, point out that maintenance costs depend on the number of vehicles using the infrastructure and their speed. The EU's CBA guidelines suggest using a fixed amount of maintenance costs per kilometre of track of 37,500 € per kilometre per year. In the present analysis, this would result in no change, as no infrastructure components are removed or added. In general, maintenance costs on existing infrastructure cannot be easily allocated if incremental usage is the subject of investigation. In this case, using the short-run marginal costs is the best way to allocate costs to the originator (Andersson M. , 2008); however, these are hard to determine on the per-use basis.

#### 4.2.2. Vehicle Operating Costs Including Maintenance

Operating costs accrue from running a vehicle or any kind of system and have to be included to the cost calculations. In order to quantify these operating costs, Tao et al. (2011) use fixed amounts per seat kilometre offered which they obtained from earlier studies. In order to estimate the total operating and maintenance cost, they multiply them by the length of the proposed route network and the forecasted number of train rides.

In the Connell case study, the Becket Group (2018) includes as benefits the reduced operating costs of 0.071 $US per transported tonne mile, multiplied by the expected number of tonne miles shifting from road to rail. Additionally, an amount of 3.75 $US per gallon of diesel is attributed to lower fuel consumption of rail and added to the benefits. The Northwest Seaport Alliance chose the same approach in their Seattle analysis, however with a different estimate of 1.27 $US less for a per-mile-operating cost of trains compared to trucks.

A more comprehensive definition is given by Siciliano et al. (2016, p.5), stating that operating costs include "all the data on the disbursements foreseen for the purchase of goods and services,

[4] The German Ministry of Transport and Digital Infrastructure commissioned and distributes this report which was then created by PTV Planung Transport Verkehr AG, PTV Transport Consult GmbH, TCI Röhling – Transport Consulting International and Hans-Ulrich Mann

which are not of an investment nature since they are consumed within each accounting period. They include the direct production costs (consumption of materials and services, personnel, maintenance, general production costs)". More specifically, they detail cost of wagons including maintenance, personnel, energy, shunting, transhipment, traction units (maintenance, overhaul, insurance) and infrastructure maintenance. However, and the same holds for Cascajo (2005), only results but no calculations are explained.

Wang et al. (2014) took annual cost indications from the Bangladesh Railway Company and extrapolated them to the projected number of trains operating after the implementation of each of the different upgrade scenarios. They included yearly maintenance cost per locomotive and passenger cars for different train types, yearly cleaning costs per train set, average fuel consumption per trip, the total salary and additional benefits of operating staff and ticket collectors, general administration and infrastructure administration cost of the network. This information is aggregated to a total mileage cost per train per 100 km, but without any distinction between different speed levels.

Via Consulting and Railistics (2014) calculate average costs for operating a locomotive at 152 € per hour excluding fuel and personnel, 45 € per hour per train are attributed to a representative mix of wagons and 75 € of wages per operating hour. In their study, they assume that all positive and negative effects with respect to energy costs and track access costs were too complex to calculate and most likely would cancel each other out anyway. Therefore, no specific values are indicated. Interesting is the fact that they estimate a number of additional resources they would need in order to maintain the schedule, estimating that 10% of the entire rail freight equipment and personnel would have to be added, which was equivalent to 460 € millions.

The CBA guide of the EC provides an example calculation, where the same approach is followed. Track-access charges and vehicle operating costs are assigned a monetary value per train and kilometre (e.g. for freight trains access charges of 3.29 € and operating costs of 4.01 €), which are then multiplied by the estimated distances. This implies that no difference occurs under different speed levels.

The same procedure is recommended for truck and barge operating costs, which include costs of ownership, personnel, fuel and distance-based maintenance costs (BVWP handbook, 2015).

### 4.2.3. Value of Time and Congestion

According to Landau et al., the value of time (VoT) "is a major component of benefit-cost analysis (…) and is used in the evaluation of projects that promise travel speed improvements or travel delay reductions" (2016: 24). The EC guidelines on CBA confirm this view, stating: "Travel time saving is one of the most significant benefits that can arise from the construction of new, or improvement of, existing transport infrastructure" (European Commission, 2014: 90). The idea is that, as with external costs, the non-monetary benefits of travellers in terms of saving time, improved comfort and reliability should also be valued. In the context of this study, travel times for passengers are irrelevant, but cost or benefit implications for truck or rail drivers will be included in the congestion cost calculations and are thus excluded from the VoT to avoid double counting.

With respect to freight transport, also the cargo is time sensitive. The shipments cannot be used during transport and lose value accordingly. This is related to the value of the goods (i.e. the tied up capital) and the state of the goods, which might change (e.g. for perishable products). Accordingly, perishables and containerized goods have the highest VoT, whereas it is rather unimportant for bulk items such as ore or coal (European Commission, 2014). This is confirmed by the BVWP handbook (2015), even stating that the latter didn't have any significant VoT at all, thus valuating them at zero. For other goods, the following numbers are provided as average rates, including cost of tied capital, impact on logistics, production and sales, and loss risk.

*Table 2: VoT for Different Freight Types*
*Source: BVWP handbook (2015)*

| Freight type | VoT (€$_{2013}$ per tonne and hour) |
|---|---|
| Containerized traffic | 1,180 |
| Foods | 1,011 |
| Stones, Earths | 0,374 |
| Mineral oil products | 0,746 |
| Chemical products, fertilizers | 0,727 |
| Metals | 0,827 |
| Machines, vehicles | 1,506 |
| Others | 0,201 |

Lovett, Dick & Barkan (2016) choose a different approach. They distinguish between perishables, bulk and others and assign a daily discount rate of 15%, 5% and 10% respectively. The total value of the transported goods decreases by this daily rate.

De Jong (2007) finds a value specifically for the Netherlands of 0.96 €$_{2002}$ per tonne per hour, which inflates to 1.17 €$_{2013}$[5]. This result is similar to those in the table above, although no distinction is made between different types of cargo.

[5] The annual inflation rates for 2003-2013 were approximated by the consumer price index obtained from the World Bank database on February 13, 2019 (https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations=NL).

Another dimension of time costs are congestion costs. As road traffic increases, so do the average waiting times for all transport participants. In the literature, different approaches exist including different elements. In traffic jam situations, for example, not only valuable time elapses, but also operating costs and related externalities (noise, pollutant emissions) increase during idling or slow driving. In order to account for all of these, the study of CE Delft, INFRAS & Frauenhofer ISI (2011) "consider the economic costs of time losses plus an addition due to additional fuel and vehicle operating costs under congested conditions" (2011: 57). Accordingly, they suggest 13.86€$_{2008}$ per 1,000 tkm as an appropriate marginal value for heavy-duty vehicles in the Netherlands.

#### 4.2.4. Costs of Noise

Noise is a widespread negative side effect of most forms of transport, influencing the health and the comfort of people affected. According to Clausen et al. (2012), "the faintest audible sound is at 0 dB(A); the pain threshold is about 120 dB(A)". The European Commission has issued a directive (2002/49/EC) where noise indicators are described in detail. The noise level is denoted by L and is applied to day ($L_{day}$), evening ($L_{evening}$) and night ($L_{night}$) situations. From those, an average day-evening-night noise level ($L_{den}$) is calculated. The EEA (2014) defines excessive noise pollution to be long-term average noise levels of above 55dB(A) ($L_{den}$) and 50 dB(A) ($L_{night}$) respectively. By the directive 2002/49/EC, the European Union drives the fight against noise strategically, requiring all the member states to start noise mapping programs and define measure to mitigate noise impacts by "making and (…) noise maps and action plans for agglomerations, major roads, major railways and major airports".

Given the importance that is acknowledged by many authorities, changes in noise levels are a common element of cost-benefit analyses and there are two general ways of quantifying noise effects monetarily: the contingent pricing method and the hedonic pricing method.

Contingent pricing can be interpreted as the willingness-to-pay (WtP) for a reduction of the noise level. Accordingly, the number of people, or alternatively the number of households, affected by noise emissions is multiplied by a monetary rate in order to obtain a total value for the noise pollution. This rate varies according to the noise level, typically increasing with higher decibel measurements. The EEA (2014), for example, suggests a "benefit of EUR 25 per household per decibel per year above noise levels of $L_{den}$ = 50-55 dB" (p.10).

A lower estimate is found by (Bjørner, 2004), who indicates that at a noise level of 55 dB, people were willing to pay around 2€$_{2004}$ per year, and about 10€$_{2004}$ per year at 75 dB(A). In a comparison across five countries, quite diverging values were found. In the Netherlands and the United Kingdom, the willingness-to-pay for avoiding severe noise disturbance was found to be 10€$_{2014}$

per person and year, ranging up to 20€ in Germany, 30€ in Spain and even 50€ in Finland (Istamto, Houthuijs, & Lebret, 2014).

The BVWP handbook (2015) provides value propositions for every level of noise exposure from 45 to 80 dB(A). At 50 dB(A), a noise damage of 10$€_{2012}$ per person per year is assumed, 53$€_{2012}$ at 55 dB(A) and 353$€_{2012}$ at 75 dB(A). The increasing marginal costs reflect the exponential degree of annoyance associated with noise, as an additional 10 dB(A) are perceived as doubling the disturbance. The figure below illustrates this relationship.

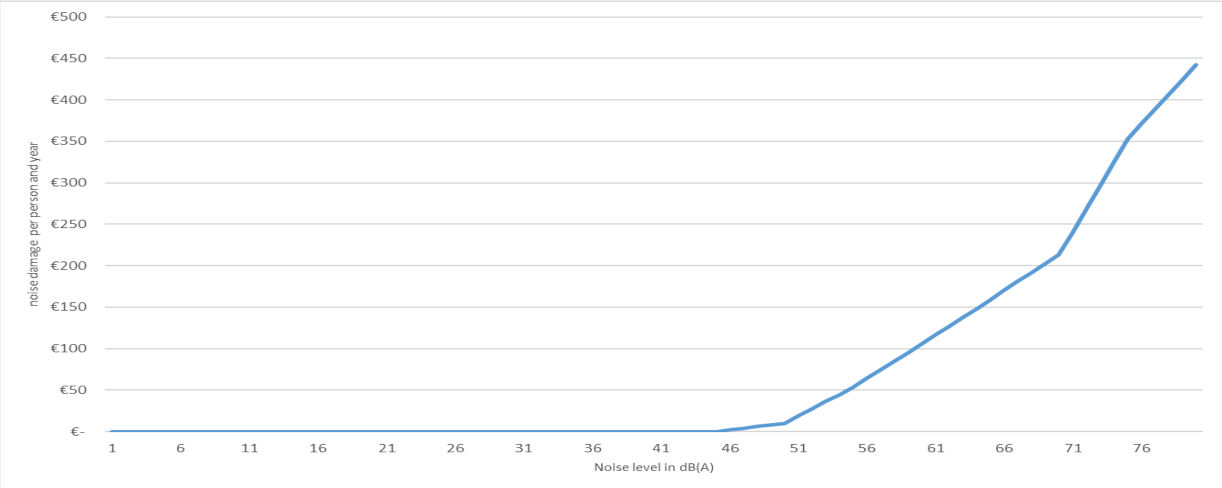


*Figure 3: Noise Costs per Person and Year at Different Noise Levels; in $€_{2012}$*
*Data Source: BVWP handbook (2015); own depiction.*

A contingent method without looking at the number of households or persons affected is used by the California HSR authority. The number of estimated vehicle kilometres (vkm) is multiplied by the marginal noise costs associated with a certain mode. They obtained the values from the EC's 2008 Handbook on External Costs of Transport, which have since been updated in 2014 by the consulting group Ricardo-AEA. For passenger and freight trains by day and night respectively, the values are shown the table 3.

*Table 3: Marginal Noise Costs of Trains for the Netherlands in $€_{2010}$ per vkm*
*Source: RICARDO-AEA (2014, Excel appendix, from https://ec.europa.eu/transport/themes/sustainable/studies/sustainable_en)*

| | | Cost per 1,000 vkm | | |
|---|---|---|---|---|
| **Mode** | **Time of day** | **Urban** | **Suburban** | **Rural** |
| Freight trains | Night | 2,634.10 € | 104.29 € | 130.13 € |

Likewise, Vierth, Sowa & Cullinane (2019) suggest marginal noise costs of 0.75€ per vehicle kilometre for freight trains regardless of the environment.

While the European Commission suggest using the contingent method based on marginal noise costs, the hedonic method is a vastly used approach. It uses data from the real estate sector under the assumption that properties lose value if they are subject to high noise levels. In the context of a project CBA, the change in the value of all real estate affected by the project is then used to measure the loss (or gain) of consumer surplus.

The EEA (2014) assumes that property prices decline by 0.5% per additional decibel over 55 dB(A) $L_{den}$. They further assert that in other research, results between 0.2% and 1.5% were found. These percentages are termed as the Noise Depreciation Index (NDI).

Schreurs, Verheijen & Jabben (2011) find an NDI in a study on Dutch airports of 0.8% at noise levels above 50 dB(A) $L_{den}$, which is in line with the EEA's findings.

In a study in the municipality of Lerum, greater Gothenburg, Sweden, Andersson, Jonsson & Ögren (2010) find that "a 1 dB increase in road and railway noise is associated with approximately a 1.2 and a 0.4% decrease in property price" respectively at 50 dB(A) $L_{den}$. Above 55 dB(A), 1.7% for road noise and 0.7% for railway noise are estimated.

Likewise, in the Asian context, Chang & Kim (2013) calculate a similar NDI of 0.53% for railway noise in the city of Seoul, Korea. However, they only present the results of their study without describing the original data set and noise levels in Seoul.

With respect to road traffic, the same methods as described for rail can be used. Equivalent to table 3, table 4 shows the marginal social noise costs for heavy goods vehicles (HGV) in the Netherlands.

*Table 4: Marginal Noise Costs of HGV for the Netherlands in €$_{2010}$ per 1,000 vkm*
*Source: RICARDO-AEA (2014, Excel appendix, from https://ec.europa.eu/transport/themes/sustainable/studies/sustainable_en)*

| Time of day | Traffic type | Urban | Suburban | Rural |
|---|---|---|---|---|
| Day | Dense | 107.90 € | 5.98 € | 0.91 € |
| | Thin | 261.82 € | 16.90 € | 1.95 € |
| Night | Dense | 196.82 € | 11.05 € | 1.69 € |
| | Thin | 477.10 € | 30.81 € | 3.51 € |

Inland waterway shipping does create noise, as operating a combustion engine and other operational processes imply. However, in accordance with the EU CBA guidelines and other studies, inland waterway shipping does not bear any noise costs (EC, 2014; Díaz, 2011; Ricardo-AEA, 2014; Vierth *et al.*, 2019)

In this study, the noise level created by passing freight trains at different speed is relevant. According to Hemsworth (2008), traction noise created by the locomotive is the main source of noise at speed below 50 km/h. Only at speeds faster than 50 km/h does rolling noise from locomotives and wagons exceed engine noise. The third source of noise, aerodynamic turbulences, only becomes relevant for high-speed trains going faster than 250 km/h. According to Hemsworth's depiction (figure 4), slowly passing trains emit a peak sound level of some 80 dB(A), which increases to ca. 85 dB(A) at 40 km/h, just under 90 dB(A) at 60 km/h and to ca. 95 dB(A) at 100 km/h.

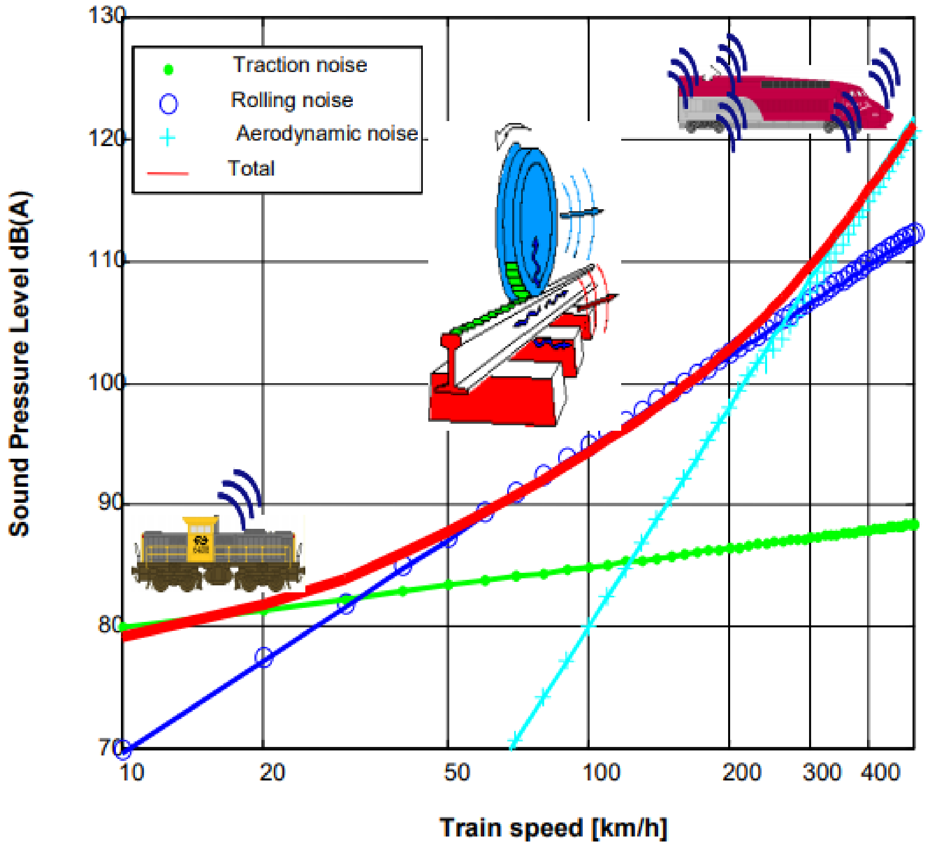


*Figure 4: Major Sources of Sound Pressure for Railways*
*Source: Hemsworth, 2008, p.7*

The study does not specify the distance to the rail tracks during the measurement; however, values published by the city of Düsseldorf in 2015 confirm the range. Accordingly, peak levels of up to 90 dB(A) were measured, with average noise levels of 62-66 dB(A) during the complete passing of the train (Westdeutsche Zeitung, 2015). The lower average speed might be explained by the technical progress, as, for example, cast iron brakes are continuously replaced with composite material brakes and bogie springs become more advanced. Figure 5 shows the development of noise emissions of its fleet described by the Swiss National Railways (SBB). Accordingly, old freight wagons ("Güterwagen") used to create noise levels of up to 100 dB(A), which was reduced to 80 dB(A) by replacing them with more modern vehicles ("moderne Güterwagen"). Likewise, new locomotives run much more quite than old models (SBB, 2011).

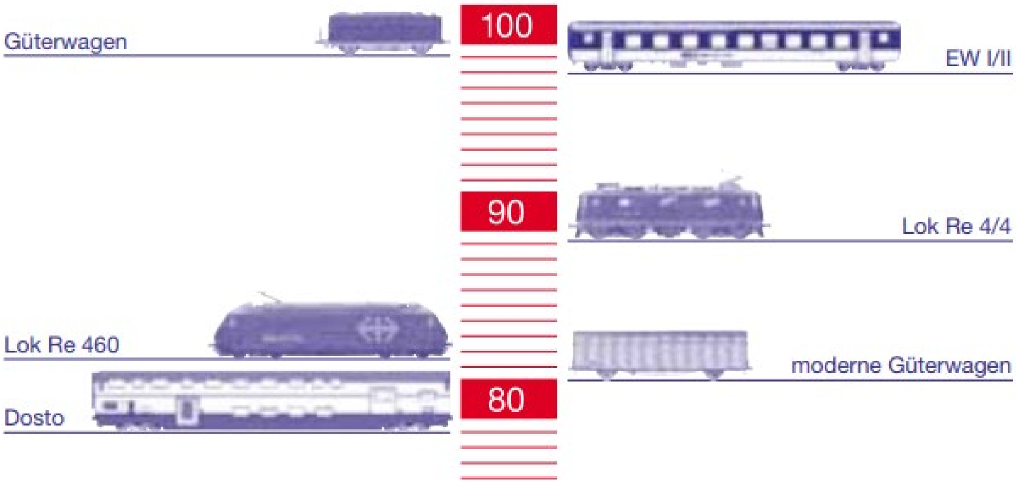


*Figure 5: Noise Levels of Different Vehicle Types*
*Source: SBB, 2011*

The relationship between speed and noise levels is also shown in the graph below, depicting noise levels in dependence of train speed. The graph for freight trains is marked in green in the top-left corner (Güterzug Fernv.), showing an average pass-by sound level of around 65 dB(A) at 100 km/h, dropping to around 61 dB(A) at 60 km/h and 57 dB(A) at 40 km/h.

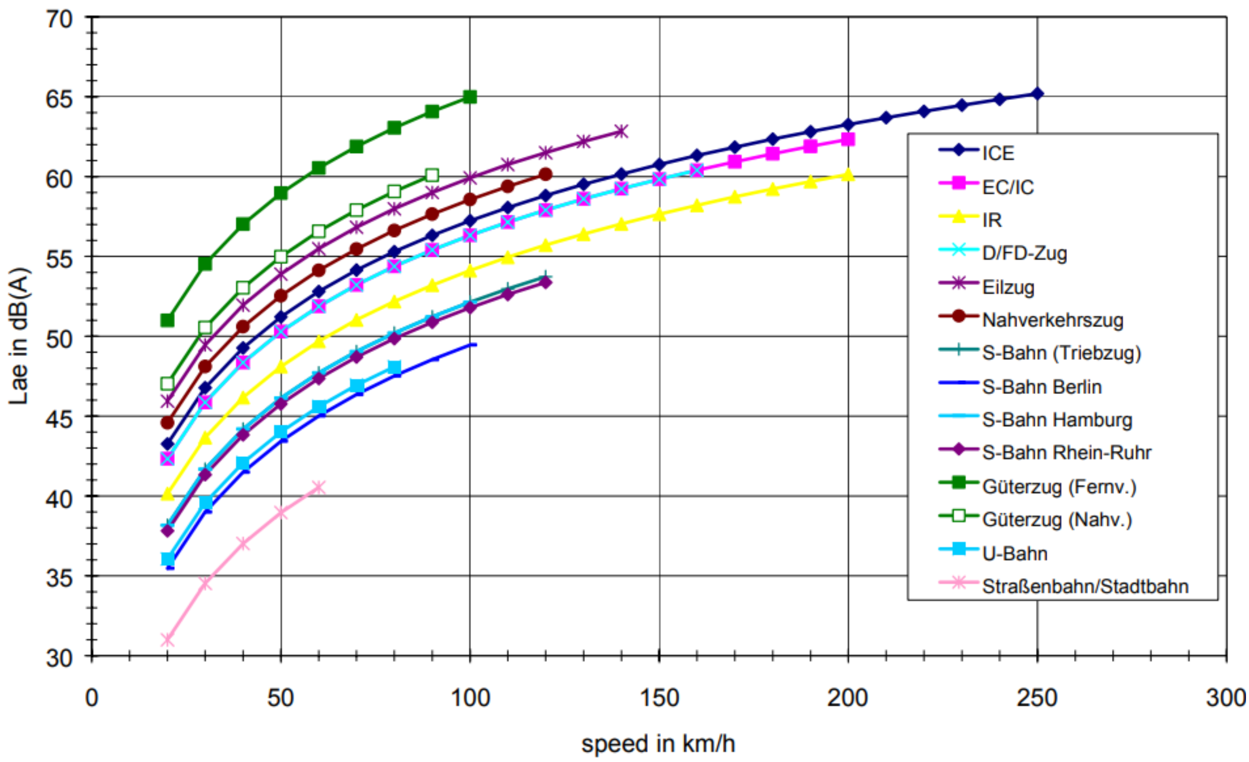


*Figure 6: Sound Pressure Level as a Function of Train Speed*
*Source: Wölfel et al., 2003*

For the final calculation of the benefits from lower freight train speed, logarithmic formulas presented in the study of Windelberg (2008) are used, which is explained in more detail in section 10.2.3 on freight rail noise reduction benefits.

#### 4.2.5. Costs of Air Pollution and Climate Change

Like noise, air pollution can have significant effects on people's lives by attacking their health directly or indirectly by destroying the flora and fauna. Therefore, the EC has also set up guidelines in order to mitigate the emission of pollutants in its "Directive 2008/50/EC on ambient air quality and cleaner air for Europe" (European Commission, 2008). As a result of this awareness, quite specific data on emissions are available and the most common method to valuate these emissions is to multiply them with an averaged distance-based rate.

The EU's CBA guidelines, for example, apply a rate of 0.015 € per passenger kilometre (p-km) for passenger cars and 0.026 € per tonne kilometre (tkm) for freight vehicles. Accordingly, a car with 4 passengers travelling a distance of 100km will emit pollutants worth 0.015 €/p-km x 4p x 100km = 6 €. Respectively, for rail, 0.007 € per p-km and 0.006 per tkm are used.

In order to calculate these distance-based rates, scientific investigations have been made, for example for average vehicle occupation, average emissions per vehicle type and driving patterns. Additionally, monetary rates for the single emission components must be obtained. The BVWP handbook, the German Ministry for the Environment (Umweltbundesamt) and the European Commissions's handbook on external costs of transport (RICARDO-AEA, 2014) all base their rates on the European Union's NEEDS project (New Energy Externalities Developments for Sustainability). An example is given in the table below, showing the external costs of different pollutants in the Netherlands in $€_{2000}$ per tonne produced. It does not only account for the effect on human health, but also on crop loss, damages to building structures and biodiversity, thus being one of the most comprehensive estimates.

*Table 5: Air Pollution Costs in the Netherlands*
*Source: Preiss, Friedrich & Klotz (2008), http://www.needs-project.org/docs/RS3a%20D1.1.zip*

| Pollutant | Cost rates (€$_{2000}$ per tonne) |
|---|---|
| $NH_3$ | 21,388 |
| VOC | 1,661 |
| $NO_X$ | 13,861 |
| $PM_{coarse}$ | 3,882 |
| $PM_{2.5}$ | 65,105 |
| $SO_2$ | 17,927 |

Combined with information on vehicle-specific emission quantities, average seat occupation and travel behaviour, average cost rate can be calculated. As an example, the table 6 shows marginal freight railway air pollution costs in €-cents$_{2010}$ as indicated in the EU's handbook on external costs of transport (RICARDO-AEA, 2014: 45):

*Table 6: Marginal Air Pollution Costs for Freight Trains in € cents$_{2010}$*
*Source: RICARDO-AEA (2014, p.14)*

| Type of freight train | Unit cost | | Load factor |
|---|---|---|---|
| | *€ct/ tkm* | *€ct/ train-km* | *ton* |
| diesel | 0.6 | 312.5 | 500 |
| electric | 0.08 | 42.2 | 500 |

It must be noted that for electrically powered trains, the above costs do not relate to direct train emissions, but to the production process of the electricity used to power the trains. An identic classification by country is provided for road transport, where different weight-based vehicle classes are considered. As this study is focused on goods transport, values for passenger cars, light commercial vehicles, buses and coaches are omitted. HGV are subdivided into eight weight classes with six Euro emission norms each. Together with a categorization into urban, suburban, interurban and motorway roads, a comprehensive table is provided.

*Table 7: Marginal External Air Pollution Costs for the Netherlands in €ct/vkm 2010*
*Source: RICARDO-AEA (2014, Excel appendix, from https://ec.europa.eu/transport/themes/sustainable/studies/sustainable_en)*

| Category | EURO-Class | Urban €c/vkm | Suburban €c/vkm | Interurban €c/vkm | Motorway €c/vkm |
|---|---|---|---|---|---|
| 7,5 - 12 t | EURO III | 8.4 | 6.0 | 4.9 | 4.7 |
| | EURO IV | 5.1 | 4.0 | 3.4 | 3.3 |
| | EURO V | 4.8 | 3.7 | 2.0 | 1.3 |
| | EURO VI | 1.5 | 0.7 | 0.4 | 0.3 |
| 12 - 14 t | EURO III | 9.4 | 7.0 | 5.5 | 5.0 |
| | EURO IV | 5.7 | 4.6 | 3.8 | 3.5 |
| | EURO V | 5.2 | 4.0 | 2.2 | 1.4 |
| | EURO VI | 1.4 | 0.6 | 0.4 | 0.3 |
| 14 - 20 t | EURO III | 12.1 | 9.0 | 6.9 | 6.0 |
| | EURO IV | 7.1 | 5.8 | 4.7 | 4.2 |
| | EURO V | 7.2 | 5.9 | 3.3 | 1.8 |
| | EURO VI | 1.7 | 0.9 | 0.5 | 0.3 |
| 20 - 26 t | EURO III | 15.3 | 11.5 | 8.9 | 7.7 |
| | EURO IV | 8.9 | 7.5 | 6.0 | 5.3 |
| | EURO V | 8.1 | 6.6 | 3.6 | 2.1 |
| | EURO VI | 1.7 | 0.9 | 0.5 | 0.4 |
| 26 - 28 t | EURO III | 15.8 | 11.9 | 9.2 | 7.8 |
| | EURO IV | 9.2 | 7.7 | 6.2 | 5.4 |
| | EURO V | 8.2 | 6.6 | 3.6 | 2.2 |
| | EURO VI | 1.8 | 0.9 | 0.5 | 0.4 |
| 28 - 32 t | EURO III | 18.0 | 13.8 | 10.6 | 9.0 |
| | EURO IV | 10.6 | 9.0 | 7.3 | 6.1 |
| | EURO V | 8.1 | 6.4 | 3.6 | 2.5 |
| | EURO VI | 1.7 | 0.9 | 0.6 | 0.4 |
| >32 t | EURO III | 18.7 | 14.3 | 11.0 | 9.2 |
| | EURO IV | 10.8 | 9.2 | 7.4 | 6.3 |
| | EURO V | 8.2 | 6.5 | 3.7 | 2.5 |
| | EURO VI | 1.7 | 0.9 | 0.5 | 0.5 |

The issue of carbon emissions driving the climate change is treated separately in the study. Based on 90€$_{2010}$ per emitted tonne of $CO_2$, the following marginal costs for diesel powered engines and heavy goods vehicles accrue for both urban and suburban areas:

*Table 8: Marginal Climate Change Costs for Diesel trains in € cents$_{2010}$*
*Source: RICARDO-AEA (2014, p.60)*

| Type of train | Urban | | | Suburban | | |
|---|---|---|---|---|---|---|
| | Unit cost | | Load factor | Unit cost | | Load factor |
| | €ct/ tkm | €ct/ train-km | ton | €ct/ tkm | €ct/ train-km | ton |
| Freight diesel | 0.26 | 126.31 | 500 | 0.26 | 126.31 | 500 |

*Table 9: Marginal Climate Change Costs for Heavy Goods Vehicles in € cents$_{2010}$*
*Source: RICARDO-AEA (2014, p.59)*

| Type | EURO Class | Urban (€ct/vkm) | Rural (€ct/vkm) | Motorways (€ct/vkm) | Average (€ct/vkm) |
|---|---|---|---|---|---|
| 7.5-16t | EURO-III | 5.70 | 4.30 | 4.20 | 4.80 |
| | EURO-IV | 5.30 | 3.90 | 3.70 | 4.40 |
| | EURO-V | 5.30 | 3.90 | 3.70 | 4.40 |
| 16-32t | EURO-III | 9.70 | 7.20 | 6.20 | 7.60 |
| | EURO-IV | 8.90 | 6.50 | 5.50 | 7.00 |
| | EURO-V | 8.90 | 6.50 | 5.50 | 7.00 |
| >32t | EURO-III | 12.10 | 9.00 | 7.50 | 9.10 |
| | EURO-IV | 11.20 | 8.10 | 6.70 | 8.30 |
| | EURO-V | 11.20 | 8.00 | 6.70 | 8.30 |

### 4.2.6. Costs of Accidents

Accidents are a by-product of transportation, due to either human error or mechanical failures, and are costly to both the individuals involved and the public. In a CBA, these costs must be estimated and included into an evaluation based on observed past events. As these differ between the single modes, a shift of passengers or cargo to safer modes can result in social benefits in the scope of the project. Variables in the calculation for each mode are accident rates (e.g. per trip kilometres), average number of injuries and fatalities per accident, material damage, projected traffic flow and specific cost rates per incident. These cost rates include direct costs (e.g. for injury treatment, repairs, administrative costs for police, insurances, legal proceedings) and indirect costs as loss of productivity to society and the WtP for accident avoidance (European Commission, 2014). Tao et al. (2011, p.40), for example, use a Swedish study and calculate with "USD$2.54 million per statistical life saved, USD$0.45 million per avoided serious injury and USD$0.02 million per avoided slight injury". Similar values are suggested by the BVWP handbook (2015), with 2.48m €$_{2012}$ for fatalities, 0.29m €$_{2012}$ for severely and 0.018m €$_{2012}$ for slightly injured persons. In the USA, minor injuries are valued at 0.027m $USD_{2012}$ severe injuries at 2.46m $USD_{2012}$ and fatalities at 9.23m $USD_{2012}$ (California High-Speed Rail Authority, 2014). As with other cost components, some marginal cost rates are calculated based on the direct and indirect costs. In the Seattle terminal extension CBA, for example, applies 0.16 US $cents_{2016}$ per train mile for railways and 0.01 and 0.02 US $cents_{2016}$ respectively for truck miles on urban and rural highways (Northwest Seaport Alliance, 2016). The BVWP handbook's values are higher, but quite similar in their relation to each other with 0.034€ per vkm for road traffic and 0.353€ for railways (Bundesministerium für Verkehr und Digitale Infrastruktur, 2015). Rail is a comparably safe mode with both total and average costs well below road freight transport. A damage of 0.20$€_{2008}$ per tkm and a total of 70€m per year in the EU are caused by railway freight accidents, while road freight causes 17$€_{2008}$ and 38,280€m respectively.

Once this is accounted for, the safety advantage of rail versus road is apparent, as shown in the study by CE Delft, INFRAS and Fraunhofer ISI (2011), where rail has much lower average accident costs per p-km and tkm than any road-based mode. While they assume 0.60 $€_{2008}$ per 1,000 p-km for passenger rail services and 0.20 $€_{2008}$ per 1,000 tkm for freight rail, costs are much higher at 33.60 $€_{2008}$ and 17.00 $€_{2008}$ respectively averaged across the road-based modes. Interestingly, no accident costs are provided for inland waterway shipping.

*Table 10: Marginal Accident Costs for Different Modes, 2008*
*Source: CE Delft, INFRAS and Fraunhofer ISI (2011, p.88)*

| Segment | Transport Mode | Total Costs (mio. €/year) | Average Cost (Pass.: €/1,000 pkm Freight: €/1,000 tkm) |
|---|---|---|---|
| | **Total** | **225,340** | |
| Freight | LDV | 18,680 | 56.2 |
| | HDV | 19,600 | 10.2 |
| | Road freight total | 38,280 | 17 |
| | Rail | 70 | 0.2 |
| | Inland waterways | n/a | n/a |

### 4.3. Freight Transport Elasticities

Elasticities are used to express percentage changes in a dependent variable as a result of a percentage change in a different independent variable. In the field of transportation, this can have a multitude of dimensions, such as various cross-price elasticities (how does demand for rail freight transport change if operating costs for trucks increase?), own-price elasticities (how does demand for rail freight transport change if freight rates increase?) or macro-economic elasticities (how does demand for rail freight transport change if GDP increases?). It is important to acknowledge the *ceteris paribus* condition for elasticities, meaning that these percentage effects in the dependent variable only occur if everything else remains constant (de Jong et al., 2010). Naturally, this is a very bold assumption, but it is necessary to keep in mind in order to interpret elasticities correctly and to not regard them as the absolute truth. Furthermore, these elasticities vary across types of mode, trip lengths, the geographic and temporal setting, and countless other scenarios (Brogan, et al., 2013). Thus, there is also a number of studies with differing methods, scopes and, consequently, differing results.

Beuthe, Jourquin & Urbain (2014) deliver a comprehensive review of the literature, including 20 studies published between 1979 and 2010. They cover different methodological approaches in terms of geographic scope, aggregation level (e.g. the entire economy or distinguished by commodity groups), estimation models or the type of elasticity. The following results are an excerpt of their work.

The oldest study, originally published by Oum (1979), indicates an own-price elasticity for freight rail of -0.29 and -0.16 for trucks in Canada, using aggregated industry data. Lewis and Widup (1982), looking at the transport of manufactured cars in the USA, estimate elasticities of -0.92 to -1.02 for rail and -0.52 to -0.67 for trucks. Abdelwahab & Sargious (1992), too, focus on the USA and use simultaneous equations to conclude from shipment sizes to the choice of either truck or rail. Indicated elasticities for rail are between -2.19 and -0.75. Lenormand (2002) finds values in between the previous studies investigating railway freight demand in France, differentiating between conventional shipments of single items and full-wagon loads. He finds conventional shipments to be slightly more elastic in the short run (-0.29 and full wagons -0.51), but less elastic in the long run (-0.37 and -0.12 respectively). De Jong (2003) studied the effect of transport costs on tonne kilometres across the EU, more specifically Belgium, Italy, Norway and Sweden. He concludes that demand for rail transportation was much more elastic (-1.40 to -3.87) than for trucking (-0.4 to -1.01), which was confirmed by Friedlaender and Spady (1980), who find similar results. The latter, however, distinguish between eight different commodity groups. This is intuitively a reasonable approach, as different goods have different sensitivities towards price or travel time changes (compare section 2.2.3 on the value of time). Transport of commodities with a low value-weight-ratio, such as ore or coal, will be more sensitive to price changes, while transport of high-value goods (e.g. machinery, containerized merchandise) are more sensitive to transport-time changes.

This is confirmed by Beuthe, Jourquin & Urbain (2014), who find very low price-elasticities for chemical products across all modes (e.g. 0.03 for trucks) and considerably higher ones for iron ore and scraps (e.g. 0.82 for trucks). They used a 1995 data set for Belgium, which is the same as used in Jourquin, Beuthe & Ha Koul a Njang (1999). Both studies apply a network modelling technique and arrive at results of similar magnitude.

Jourquin, Tavasszy and Duan (2014) look at a European Network modelling the effects of a 5% increase in road transport costs. The resulting increase in rail activity implies elasticities of 0.54 to 0.98. The focus of their work was the influence of pre-haulage and post-haulage distances on the main leg of the freight service.

Likewise, Puwein (2009) indicates road freight price-elasticities ranging from -0.04 (machinery) to -2.97 (paper, plastics, rubber products) and rail freight price-elasticities of -0.02 (foodstuff, coal) to -3.55 (machinery). These values were taken from Oum, Waters II & Yong (1990) and are therefore considerably older.

Marzano & Papola (2004) use a multi-regional input-output model in order to simulate the effects of delivery time changes on modal split in Italy. They suggest that a 10% decrease in railway transport time will result in a 65.26% increase in tonnage transported by rail. This increase will mainly occur in the distance segments of 250-500km and 500-750km, as the competition with trucks is most prevalent in these segments. Price elasticities are not part of this study.

One of the most recent studies, albeit on a very aggregate level, and was published by the Victoria Transport Policy Institute in Australia. However, like in Puwein's work, the report does not present original elasticities, but simply indicates what Small & Winston found in 1999: with respect to price, freight rail demand elasticity is -0.25 to -0.35 and -0.3 to -0.7 with respect to transit time. Curiously, the exact same elasticities are indicated for truck transportation (Litman, 2018).

## 4.4. Summary

In section 4.1 the different variables and methodologies used in the existing literature were discussed. As a result, infrastructure maintenance, operating costs, noise, air pollution, climate change emissions, congestion, accidents and transportation time are the variables under investigation in the scope of this study. The second section identified a gap in the research regarding the effects of limiting speed of freight trains. There are only few publications found on the subject, which makes this research all the more relevant.

Section 4.3 confirms that there are many different parameters that can be selected while calculating elasticities that lead to a wide array of results. Furthermore, the methodology is quite different in these studies and relies mostly on aggregate time-series data or theoretical models based on cost functions for different modes.

# 5. Description of the railway freight industry in the Netherlands

Section 5 will provide an overview of the Dutch railway freight industry in 2019. At first, the supply side will be characterized. This includes operational aspects (e.g. with respect to rolling stock, the production system) as well as economic aspects, such as the cost structure. Subsequently, the demand side is portrayed, depicting the customers and their requirements. Finally, competing modes are briefly presented with emphasis on competitive advantages they may have over one another. In the later course of this study, the three concepts of wagonload trains, block trains and combined transport will be investigated separately regarding their elasticities and modal shift. Therefore, this section serves to explain the differences between these production systems and to supply the reader with background information regarding the railway freight industry.

## 5.1. Railway Freight Supply Side

Generally speaking, the output, i.e. the product, of the railway freight industry is the service of goods transportation carried out by a train. Compared to passenger services, there are two fundamental differences. Firstly, the freight does not access the trains autonomously where train stations are the main access and exit points, but the cargo originates from various sources and has to be included into the system separately. Secondly, while a person is the single common unit in passenger services, cargo comes in different shapes and sizes. Therefore, different types of railway freight production systems have emerged that are part of the Dutch freight rail system. These can be categorized into wagonload trains, block trains and combined transport (compare e.g. Troche, 2009). From the sender's perspective, the choice of the system used depends on different aspects, such as size of the consignment (full-train load versus less-than-full-train load), the type of cargo (bulky items, liquids, containerized…) or the availability of a private rail siding on the production site.

### 5.1.1. Wagonload Trains

When consignors cannot produce a sufficient amount of freight to be shipped to fill an entire train, they have the option to include their consignment into the wagonload system. Wagonload trains consist of different types of cargo with different consignors and origin-destination pairs. While the different consignors can have multiple wagons in a specific train set, so-called wagon groups, a single wagon is the smallest consignment unit. That is, the inside of a wagon belongs to the exact same shipment. In order to assemble these wagonload trains, the senders load their freight into the

wagons, mostly on factory premises with own rail sidings, from where they are driven to a rail cargo node by a regional feeder train. By shunting, the different wagons are re-organized into longer train sets for the main trip segment. Upon arrival at a node close to the destination, the train is broken up and the single units are ferried to their destination for further processing of the goods. In order to run this system efficiently, it is important to group different consignments and assemble larger trains in order to reduce unit costs. However, difficulties arise from the operational peaks. Modern production plans with just-in-time characteristics try to avoid storage costs by producing during the day and loading the goods directly onto trains for night time transports. Thus, with respect to shunting equipment and personnel, evening (departure) and morning (arrival) peaks create bottlenecks in the nodes, with inefficient off-peak hours (Weigand, 2008).
Additionally, the variety of different wagon types (e.g. for liquids, bulk goods, merchandise, metal products; compare Fischer, 2008) causes complexity in the provision of rolling stock.

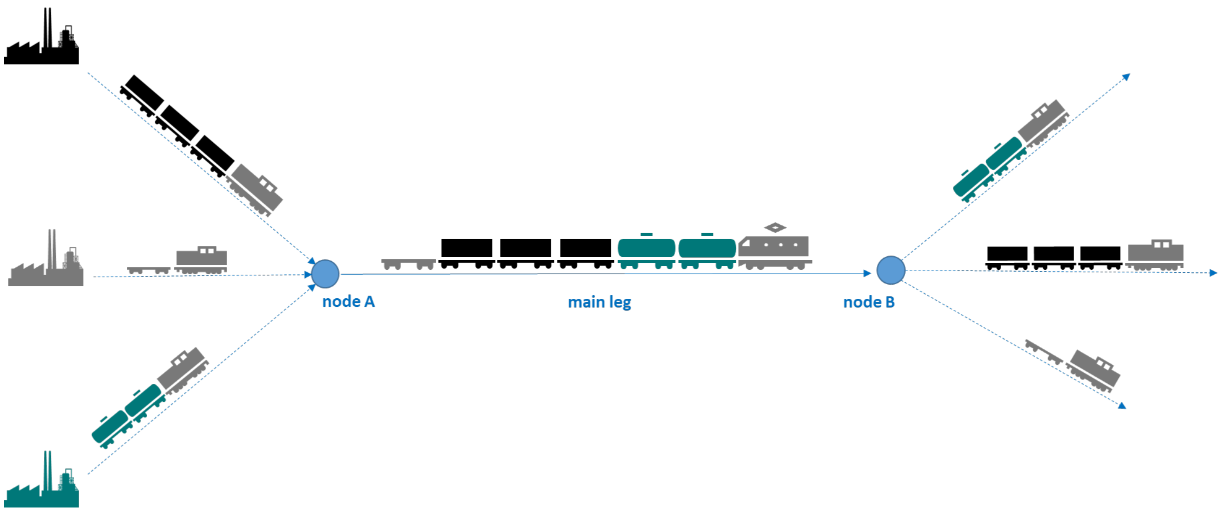


*Figure 7: Wagonload Train System*
*Source: Own depiction*

### 5.1.2. Block Trains

Block trains are complete transports of a single commodity with a single origin-destination pair for the entire train set. They may pass through the same nodes as other train types in order to transition from side tracks to the main rail network, but the single carts are never separated during the journey. Thus, no shunting processes are needed, which is why cycle times and handling costs are lower than for any other type of freight trains. Likewise, only one type of wagon is needed, which further reduces complexity. Goods typically transported by block trains are rather price-sensitive and voluminous bulk items, where long trains covering long distances with a lower energy consumption can reduce unit costs (Weigand, 2008). Examples are coal and ore transports from mines to iron works, grain from large farms to mills or liquid chemicals between producer and processor. Likewise, automobile transports from the assembling factory to a sea port can reduce storage costs by integrating the transport schedule into a just-in-time supply chain (Fischer, 2008). Typically, if a firm uses block trains in their transport processes, the freight rail system is an integral part of the supply chain and the firm owns infrastructure like private tracks and sidings to connect its own plant to the public railway network.

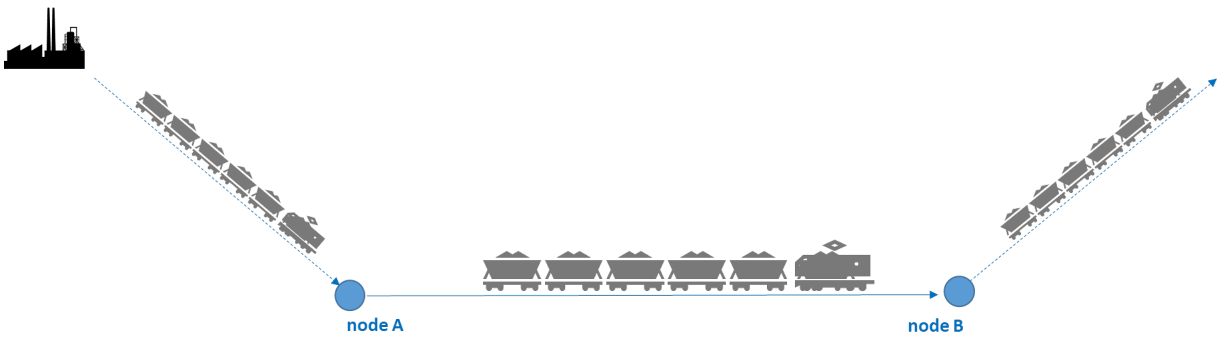


*Figure 8: Block Train System*
*Source: Own depiction*

### 5.1.3. Combined Transport

In the past decade, e-commerce has become a significant trend and accordingly, the number of shipments increased with declining shipment sizes. In this goods segment of merchandise, truck transport has gained a large piece of the market share due to its advantages in flexibility and lead times. A competitive stronghold in the railway freight industry are so-called combined transports. These are intermodal forms of transport, meaning that different modes are involved, mostly trains and trucks, but also sea ports (e.g. Rotterdam, Amsterdam) and inland waterways (e.g. Rhine or Meuse) are connected. Frequently, forwarders organize these transports by bundling individual shipments with a common general shipment direction in large standardized containers that are compatible with every mode in the chain. Trucks or ships feed these containers into freight train terminals, where they are loaded onto wagons. Similar to wagonload traffic, these wagons are then driven to nodes where they are assembled into larger train sets for the main haul. Upon arrival, the single wagons are divided, broken down and the containers loaded onto trucks for post-haulage. Some of these wagons are designed to carry entire flatbed truck trailers, which reduces handling times in the intermodal terminals.

Most commonly, there are fixed shuttle services on highly frequented transportation corridors. If there is sufficiently stable demand, freight trains operate between two container terminals on a fixed schedule and capacities are reserved by forwarders (Weigand, 2008). The trains are usually never broken up in order to reduce complexity and produce a cheaper transportation service. Such highly frequented shuttle systems with densely planned round-trips are necessary to achieve a sufficient level of efficiency that makes the mode competitive with road services.


*Figure 9: Combined Transport System Integrated into Wagonload Train System*
*Source: Own Depiction*

### 5.1.4. Freight Railway Cost Structure

Railways, just like most other forms of transportation, require a substantial amount of infrastructure investment. In Europe, the EU has induced competition in the railway sector after decades when state-controlled monopolies represented the common structure. These, however, led to inefficiencies and the EU has since legislated four railway packages in order to increase competitiveness with other modes. These packages prescribe, amongst others, the separation of infrastructure provision and operations, undiscriminatory access to infrastructure capacities, a harmonisation of different infrastructure systems and uninhibited cross-border operations. Since the implementation of these packages, which is partly still going on, the operators have to pay access charges in order to use the infrastructure. These are an essential part of a freight railway operator's cost structure, along with personnel, energy, rolling stock (i.e. wagons and locomotives) and administration (Hagenlocher & Wittenbrink, 2015). The figure below indicates a common cost structure of such operators. Although the percentages may vary by country (different countries may for example have different track access charges and wage levels) and type of train (e.g. electric locomotives vs. diesel locomotives, standard flatbed wagons vs. special dangerous goods wagons), the chart gives an impression of how the cost side is composed.

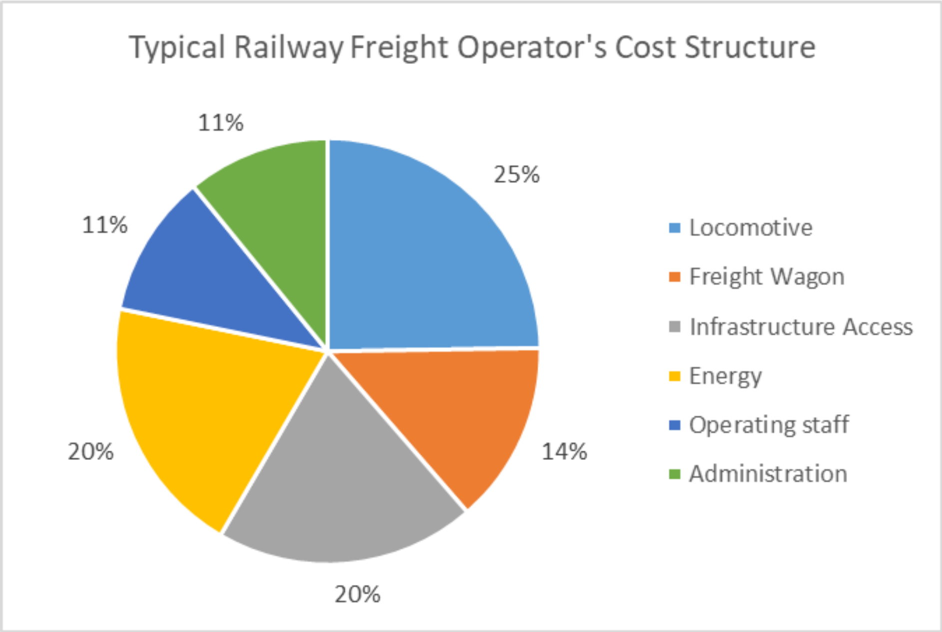


*Figure 10: Typical Railway Freight Operator's Cost Structure*
*Source: Hagenlocher & Wittenbrink (2015, p.18); own translation.*

The difference between wagonload and block trains is presented by Helmenstein (2013) in the Austrian context, comparing wagonload trains with block trains. Especially less shunting (i.e. the assembly of loaded wagons to form complete trains), simpler commercial processing and lower wagon costs reduce complexity, and thus the costs, significantly.

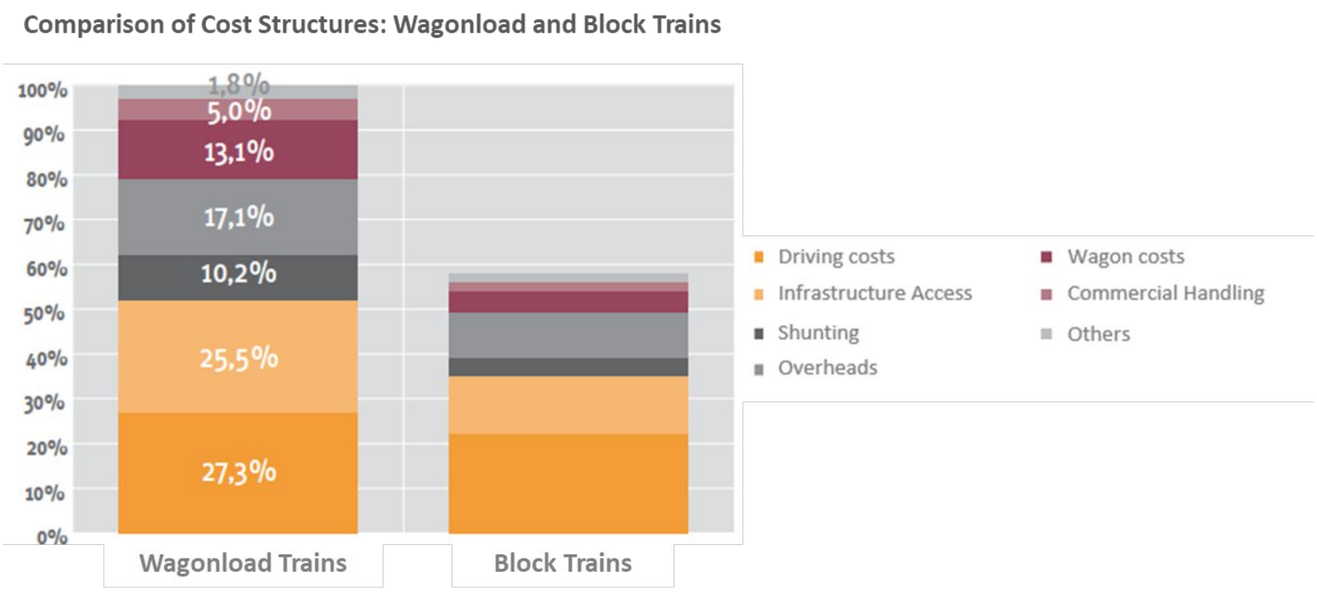


*Figure 11: Comparison of Cost Structures: Wagonload and Block Trains*
*Source: Helmenstein (2013, p.21); own translation.*

The significant costs for locomotives, track access and train drivers implies decreasing incremental costs (i.e. the costs of adding another unit, in this case for example a wagon) and economies of scale. Thus, train operators will try to make use of the maximum allowed train dimensions. In the Netherlands, network providers ProRail have set those to be a length of 740 metres and an axle weight of 22.5 tons for the main sections of the national network (ProRail B.V., 2017).

## 5.2. Railway Freight Demand Side

Generally speaking, railway freight customers are quite price-sensitive. Railway freight transportation is considerably less flexible than trucking, as logistical processes, such as loading or shunting, take longer and require special infrastructure (e.g. rail sidings, reach stackers, etc.). Thus, rail transport becomes viable at longer distances or when transporting weights and volumes that are not suited for trucking. As a rule of thumb, a distance of 500km is a realistic estimate for an efficient distance that renders rail transport competitive to road (BVU & TNS Infratest, 2016). However, also shorter distances can be viable. In the case of container transports, shuttles with high frequencies and a high utilization of equipment can be feasible on distances of less than 200km, as shown on the relation between the port of Rotterdam and the container terminal of Venlo. For goods transported in block trains (e.g. bulk goods, liquids, cars), the distance is lower due to the lower handling costs. The railway's competitive advantage in the bulk segment is also reflected in the volumes of different commodity groups transported by rail in the Netherlands in 2017 as shown in figure 12. These volumes are dominated by solid mineral fuels (e.g. coal), chemicals and ores. These groups are consistent with the Standard Goods Classification for Transport Statistics (NST/R) of the EC.

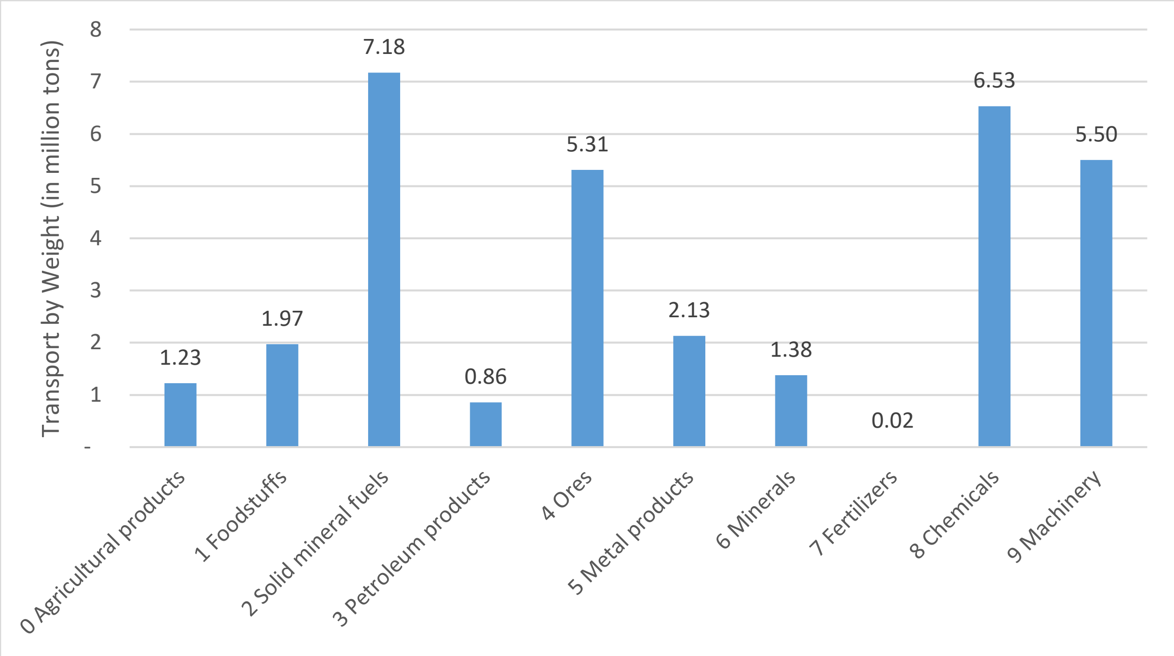


*Figure 12: Railway Transport Volumes in the Netherlands in 2017 by Commodity Group*[6]
*Data Source: Statistics Netherlands; own depiction*

Hence, the inference can be made that main customers of railway freight services are producing industries that require high-volume transports for imports and exports (e.g. steel and metal producers, chemical and pharmaceutical producers, automotive, construction, power plants).

The Dutch railway freight market is characterized by a high share of exporting activities. This is due to the port of Rotterdam's significance on the European level. High volumes of imports to high-spending countries such as Germany, Switzerland or Austria arrive at Rotterdam, are loaded onto trains and are then exported to the hinterland. Figure 13 shows the high portion of exports in the Dutch market. Domestic transport (i.e. both origin and destination are in the Netherlands) and transit traffic (e.g. from the Belgian Port of Antwerp transiting through the Netherlands going to Northern Europe) only play a minor role.

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[6] For better depiction, the commodity groups were abbreviated. Full description from Eurostat is as follows:
0 Agricultural products and live animals
1 Foodstuffs and animal fodder
2 Solid mineral fuels
3 Petroleum products
4 Ores and metal waste
5 Metal products
6 Crude and manufactured minerals, building materials
7 Fertilizers
8 Chemicals
9 Machinery, transport equipment, manufactured materials and miscellaneous materials

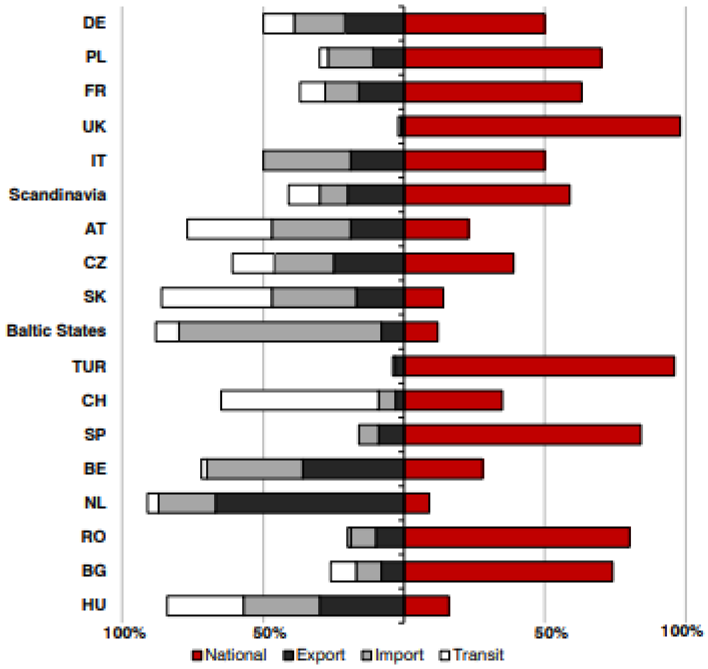


*Figure 13: Share of National and International Rail Freight Transportation in European Countries (2014)*[7]
*Source: (SCI Verkehr GmbH, 2016, p.7)*

### 5.3. Competition with Other Modes

In total, road transport is the strongest land-based mode in Europe with around three quarters of the tonne kilometres covered. Compared to this, the Netherlands have a significantly higher share of inland waterway navigation in freight transport, which is due to the high availability of natural rivers and artificial canals as well as waterside terminal facilities.

[7] DE: Germany; PL: Poland; FR: France; UK: United Kingdom; IT: Italy, AT: Austria; CZ: Czech Republic; SK: Slovakia; TUR: Turkey; CH: Switzerland; SP: Spain; BE: Belgium; NL: The Netherlands; RO: Romania; BG: Bulgaria; HU: Hungary

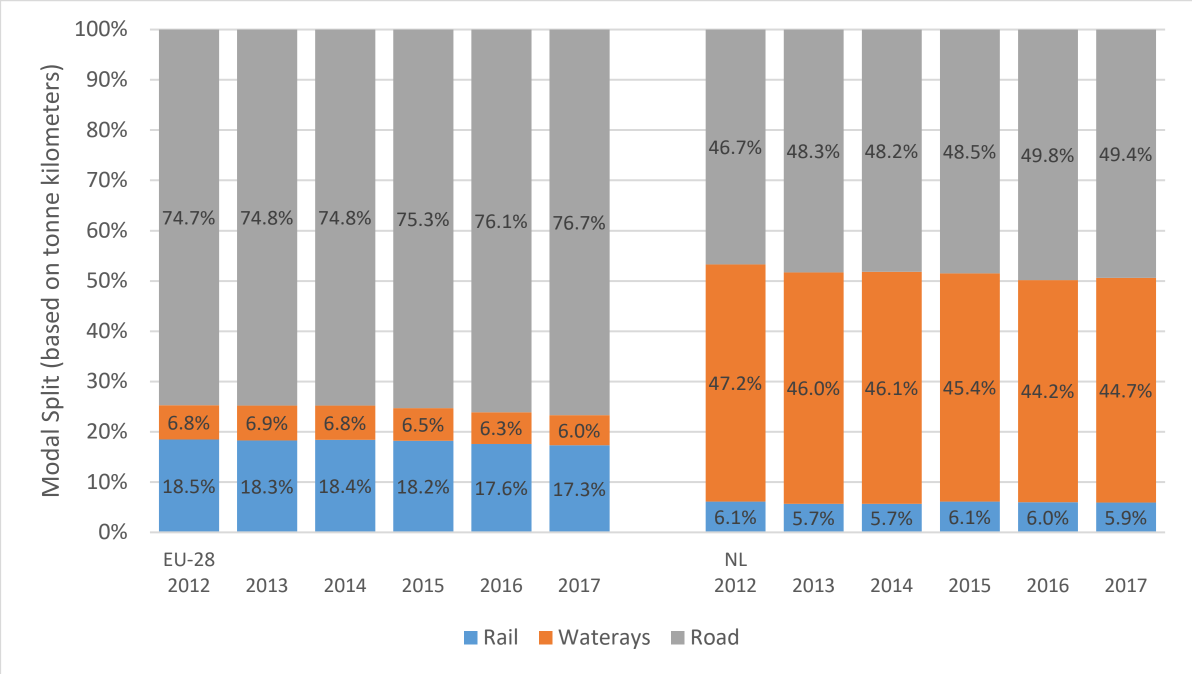


*Figure 14: Freight Transportation in the EU-28[8] and the Netherlands: Modal Split of Inland Transport Modes 2012-2017*
*Source: Eurostat (2019c), own depiction*

According to Åkerman et al. (2014, p.15), "total intra-EU freight transport amounted to 3,700 billion tkm in 2010. Road transport over 300 km contributes to 965 billion tkm", which is approximately 26,1%. While figure 14 presented data in terms of tonne-kilometres, figures 15 and 16 elaborate on the modal split in the Netherlands[9] separated by value and weight. It can be noted that the shares by weight are significantly different for those by value. This confirms the common understanding that voluminous bulk goods are rather transported by barge, while trucks carry more valuable and thus more time-sensitive goods.

[8]Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom (England, Scotland, Wales and Northern Ireland)
[9] Modes excluded are air, maritime and pipeline transports. Data only include European relations and quantities from 2017.

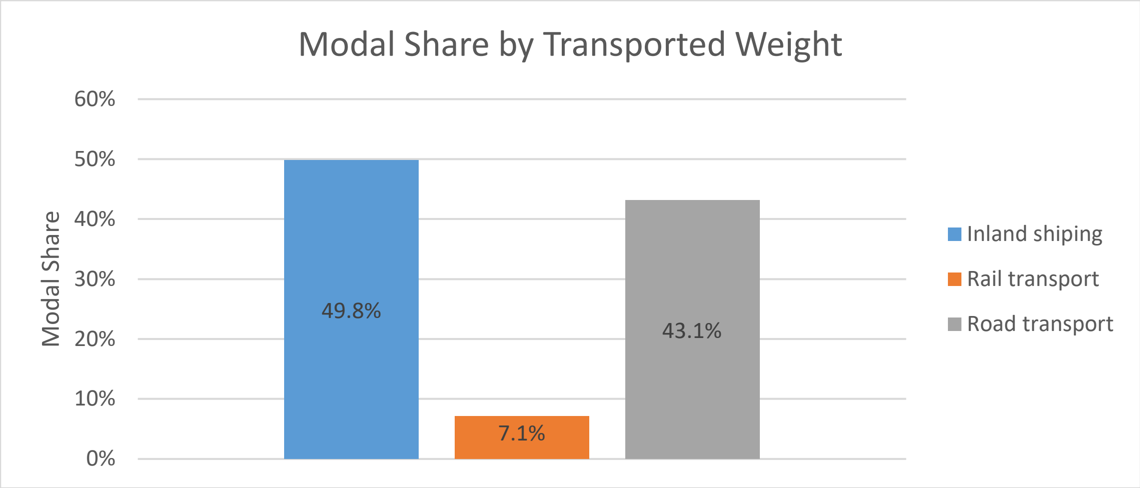


*Figure 15: Modal Share in the Netherlands by Transported Weight (2017)*
*Data Source: Statistics Netherlands; own depiction*

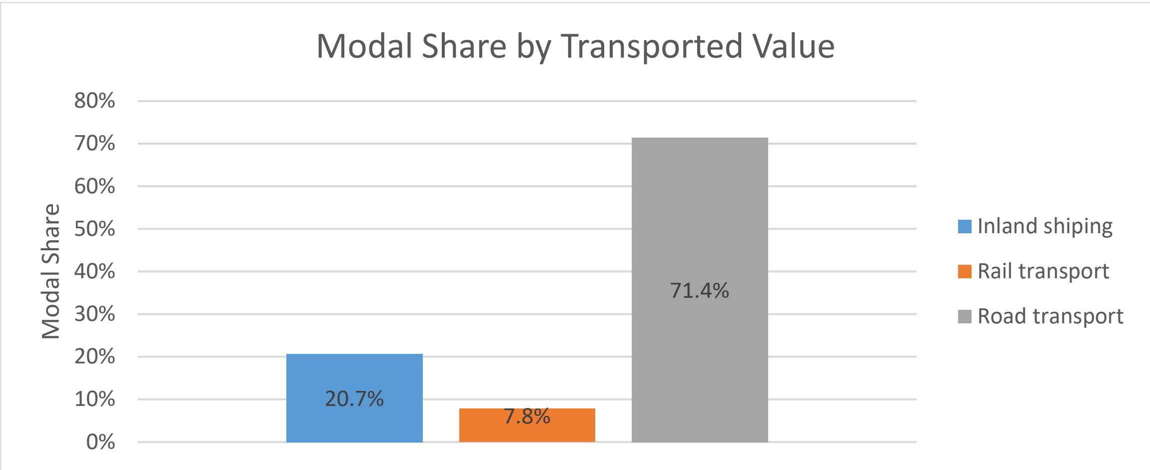


*Figure 16: Modal Share in the Netherlands by Transported Value (2017)*
*Data Source: Statistics Netherlands; own depiction*

Likewise, the statistics show the relatively weak position of freight railways in the Netherlands compared to other EU countries. Especially inland shipping is significantly stronger due to the excellent network of navigable waterways, as the Netherlands have the densest network of inland waterways in Europe (Eurostat, 2019). Furthermore, the Rhine, as one of Europe's most important waterways, connects the Dutch seaports to the economically important areas in Germany, Austria and Switzerland. Hence, it can be assumed that those goods for which water-borne transport is viable are already transported by barges. Only where ships do not satisfy certain conditions (e.g. with respect to speed or regional accessibility) can railways stand their grounds. Where flexibility and transport times are of the essence, trucking is traditionally the mode of choice for shippers, leading to the high share of goods transported on roads. The result is a sandwich position for railways between trucks and barges, almost as a niche transportation product for goods that do not fit the two main modes.

The industry portrait painted in the previous chapters serves as a basis for the research part in sections 7, 8 and 9. The different production systems are the basis to approach the topic in structured way and to distinguish between different cases. This approach allows to investigate different effects for the respective production systems, thus implicitly for different product groups and transportation distances.

### 5.4. Summary

The railway industry in the Netherlands can be categorized into three production systems: block trains, wagonload trains and combined transport services. These differ in terms of the goods they are intended to transport and the cost structure. Block trains are the mode of choice when bulky items, dry or liquid, in large quantities must be shipped over all distances and where waterways do not offer suitable alternatives. Wagonload trains are more costly to produce as this system composed multiple consignments of different consignors into complete trains, which requires more operational effort and process steps. This system is suitable for consignors who need to transport goods that are not suitable for road transport (e.g. due to weight or dangerous goods properties) in quantities that are not sufficient to fill an entire block train. The combined transport is the most flexible of the three systems, where standardized containers are transported by rail in combination with other modes. The content of a single container is mostly of higher value and does not necessarily belong to the same shipper. The trains are used to connect rail terminals (these can be part of sea ports or in the hinterland) and the fine distribution is usually conducted by trucks.

Competing modes are mainly barges and trucks. Barges compete in the bulk good segment and on long distances when a suitable river or canal is available. Trucks are more flexible and quicker during transport and loading, however they lack the capability of transporting large quantities over large distances economically. Mostly over shorter distances do they have a competitive advantage.

# 6. Methodology

In this section, the methodological approach to the research is described. Sub-section 2 expands on the data, where they come from, and what software has been used in the scope of this paper.

## 6.1. Methodological Approach

The research is divided into three major parts: firstly, the schedule analysis with the calculation of time and cost implications will answer research sub-question 1. Secondly, the expert interviews will lead to the demand effects and elasticity as stated in sub-question 2. These first two parts are inspired by the Meteren – Boxtel case study, but they are designed as a generic model that can be applied to other scenarios as well. That means that the operational cost implications are driven by the additional driving time caused by the speed limit and the elasticities are applicable to the entire Dutch railway freight market. Lastly, the cost-benefit analysis will provide answers to sub-questions 3 and 4, and thus also to the main research question, by calculating costs and benefits of the speed limit reduction and the resulting modal shift. This third part is a specific case study for the Meteren – Boxtel segment.

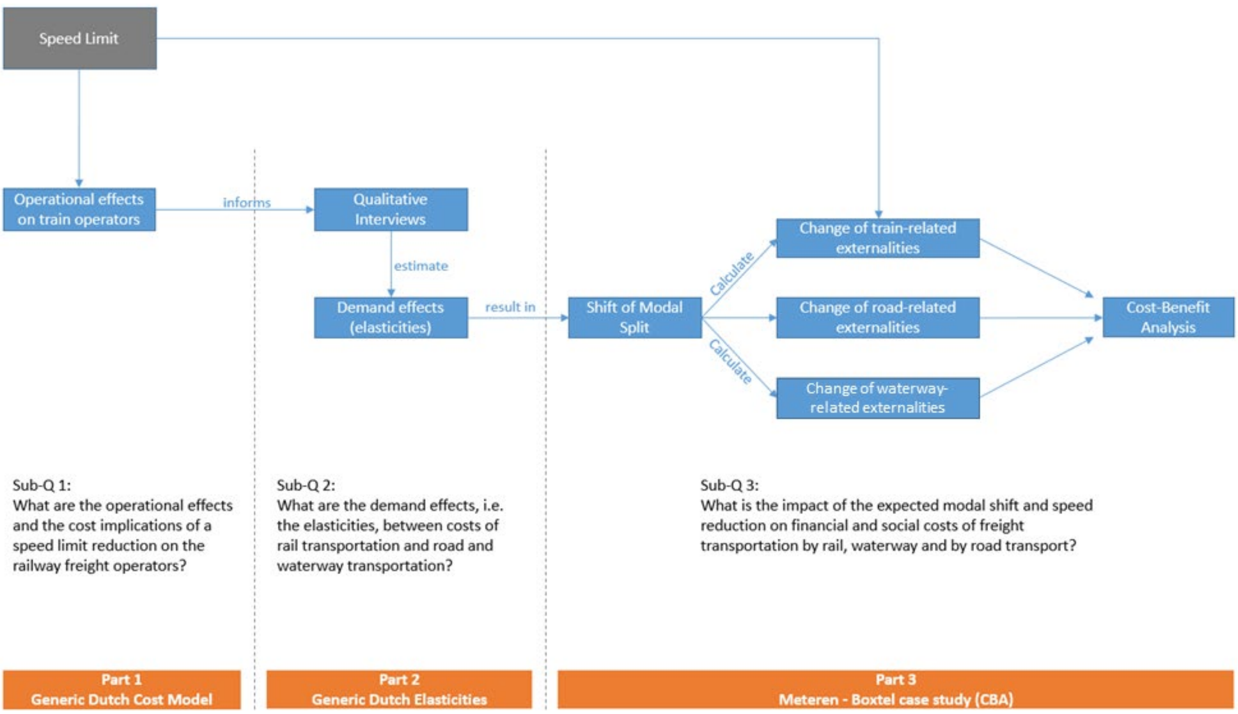


*Figure 17: Conceptual Study Overview*

The basis for the first part, the schedule analysis, is the calculation of increased trip times and the track capacity reduction with the help of the scheduling software FBS (sections 7.2 and 7.1). The longer trip times are used to calculate increased operating costs for the railway operators. On the one hand, slower operations reduce energy consumption, but on the other they may increase other costs that are based on the time of usage (e.g. wages, leases). Reserved rail path slots are endangered by slower speeds, which might result in step-cost increases. Trains on round trips might lose connections and thus require additional equipment sets and staff to be implemented. All of these effects are estimated in order to establish the magnitude of the impact on railway operations with regard to weekly scheduled freight trains. The schedule includes 1532 train connections with their origin-destination pairs, the operating company and the train type. As an outcome of the first part, the lost track capacity and the increased operating costs for the remaining railway traffic are identified for a generic segment of 32 km. This result serves to inform the interview partners about cost and time implications in the second part of the study. One restriction to this study is that only the main leg of the railway transport will be considered. Pre- and post-haulage service provided by other modes are also part of multi-modal transport chains. However, they are not in the scope of this study.

The second part of the study is dedicated to the expert interviews. The central purpose of these interviews is to answer research sub-question 2 and calculate the price elasticities for freight trains in the Dutch context. These determine the traffic volume that will shift away from rail to road or waterway transport given the cost and time increase (for rail) calculated in the first part. Each interview partner is asked to indicate their expectation regarding the modal shift for nine different train clusters determined by three train types and three distance segments, all under different cost increments. All answers are transformed into elasticities. Subsequently, a regression analysis is conducted with all the elasticities as the dependent variable and the step-wise cost increase increments being the independent variable. The results per cluster, paired with the respective results from the cost model, will determine the final modal shift including the substituting mode.

The last part of the research includes the cost-benefit analysis. The modal shift resulting from the speed limit reduction causes different financial and economic effects and different categories are considered. Financial changes will occur in infrastructure maintenance and operating costs. Economic effects include noise and air pollution emissions, climate change effects, congestion, value of transport time and potential accident costs. All of these elements are calculated for changing transport performance for rail, trucks and barges. From the results, indicators evaluating the viability of the project are calculated as an answer to the research question.

## 6.2. Data and Software

In the first section, a generic operating cost model is presented. As a basis, ProRail suggested to use the rail freight schedule data on freight trains originating from, going to or transiting the

Netherlands compiled by RolandRail (2019). These schedules include information about origin and destination of a scheduled connection, the relevant border crossings to or from the Netherlands, the type of cargo and the weekly departure days. Below is the example of a combined transport train (indicated by "containers" in the last column) from Rotterdam Maasvlakte terminal to Neuss, Germany, operated by KombiRail Europe. The train leaves Mondays through Fridays and passes the border at Venlo (Vl). The entire set of schedule data is attached in annex 4.

KombiRail EUROPE

| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41701 | ma-vr | Mvtw | 15.11 | Kfhn | 15.55/16.00 | Bd | 16.30 | Tb | 16.47 | Ehv | 17.13 | Vl | 17.51/18.12 | Neuss | Containers, rijdt* |

*Figure 18: Excerpt from the Schedule Data obtained from RolandRail*

In own research, the relevant distances within and outside of the Netherlands were added for each relation by the author, with data obtained from DB Netz AG's Trassenfinder[10] and Google maps. The distances inside the Netherlands were indicated by ProRail. Further input data in the cost model, mainly cost rates for different cost elements, were sourced from Railistics' in-house database and publicly available data. Railistics' database has been compiled over more than 600 projects and is constantly updated. It contains benchmarks of certain assets and operating costs, such as locomotives, wagons or drivers. These are obtained, for example, by requesting price quotations from locomotive manufacturers on behalf of own clients within the scope of a consulting project. The other information used (e.g. costs for electricity or track usage) are publicly available and their origin is indicated in the respective paragraphs of section 7.3 Changes in Operating Costs. These will be complemented by freely available data from various databases (e.g. Statistics Netherlands, Eurostat, Destatis[11]), such as inflation rates for price adjustments.

For the investigation of schedule implications, the program FBS (Fahrplanbearbeitungssystem, German for timetable processing system) was used. FBS is a dedicated software for planning rail operations in all segments. The tool provides a module for the timetable construction and optimization of cycle trips. Accordingly, the requirements for human and technical resources can be determined. The system is used by a wide range of customers. Railway operator can plan their round trips and resources and make long-term as well as ad-hoc offers for potential clients. Public entities can support tender requests with the tool in order to clarify their service requirements to the bidders. The tool offers the possibility to adequately model a certain origin-destination

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[10] DB Netz AG is part of the Deutsche Bahn group and Germany's railway infrastructure provider. The Trassenfinder, translating to train path finder, is a freely available online tool to plan railway trips and request track access on the German railway network. It is available under www.trassenfinder.de.

[11] These are the official national databases of the Netherlands, the EU and Germany, respectively

scenario, including various route parameters (e.g. curves, gradients, signalling), different types of rolling stock (e.g. different locomotives with different performance characteristics, different wagons) and load scenarios (e.g. loaded versus unloaded, varying train length). FBS is suited for all types of traffic in terms of passenger and freight operations, long- and short-distance relations, commuter rail or industrial railways. FBS is a fee-based product developed and distributed by the Institut für Regional- und Fernverkehrsplanung (iRFP, Insitute for Regional- and Long-Distance Traffic Planning). Railistics is a long-term customer with several licences purchased. The tool is used for consulting purposes, when customers require specialist support for schedule or infrastructure planning.

In the third step of the research, the output from the generic cost model and the elasticities obtained from the expert interviews in step two are paired with a traffic forecast provided by ProRail specifically for the Meteren – Boxtel segment. These data indicate the number of trains expected to cross the section and based on the generic model, a case-specific modal shift can be determined. This modal shift is the input for the cost-benefit analysis. The cost rates for the different cost and benefit elements stem from different public sources as indicated in the respective sub-sections of chapter 4.

# 7. Research Part 1: Effects of a Speed Limit on Freight Train Operations

In this section, the operational effect of the speed limit reduction is described in order to answer sub-question 1. If a noise-level reduction is to be achieved by means of slower driving, the impact on operating freight trains must be explored and described. The first sub-section elaborates on the changes in trip time if a generic freight train on a generic 32 km segment[12] is subject to a speed limit reduction for both alternatives compared to the base case. The second sub-section explains how the speed limit reduction will affect track capacity and, lastly, the third sub-section presents the calculation of operating costs with and without the speed reduction measure.

## 7.1. Changes in Trip Time

The analysis in FBS was designed to include deceleration into and acceleration out of a generic 32 km segment. Figure 19 shows how the driving time extends if speed is slower: the steeper the train path, the slower is the train. The first graph simulates a freight train entering the section at 8.00 o'clock (intersection on the left axis) and exiting it at 8.21 o'clock (intersection on the right axis) with a constant speed of 95 km/h. The following graphs repeat the simulation, now reducing speed to 60 km/h and 40 km/h. The driving time increases by 12.4 minutes and 29 minutes respectively.

[12] The length of 32 km is derived from the Meteren – Boxtel case study in part 3 of the study, but at this point a generic analysis of increased driving times and operating cost is conducted. This approach simulates what happens to a train driving at night in the later-to-come case study.

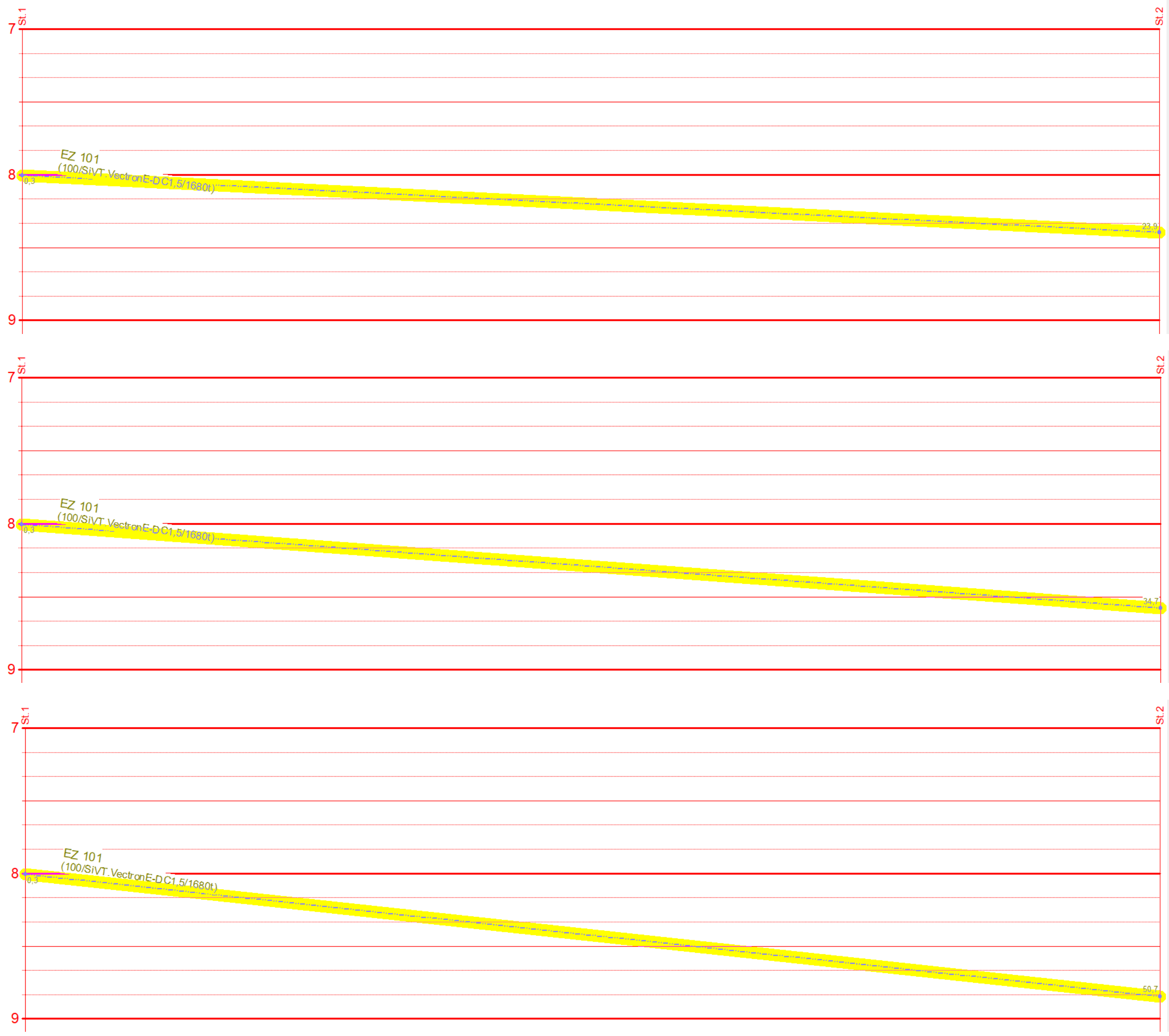


*Figure 19: Simulation of Driving Times*
*Own depiction Produced in FBS scheduling software*

## 7.2. Changes in Track Capacity

During the daily train schedule, freight trains just barely fit in between the closely scheduled passenger trains. A speed reduction causing longer travel times of only a few minutes could potentially disrupt this schedule and reduce the track capacity. However, the evaluation in FBS has shown that there is sufficient capacity along the track during the night and no freight train paths have to be cancelled. This is because the passenger traffic is thinning out during the late evening and early morning hours, and non-existent in the night. Twenty freight trains during the night hours from 23:00 to 07:00 were tested to cross the section, which is a high estimate. FBS showed no overlapping train paths, thus no scheduled connections have to be cancelled. Therefore, there is no need to consider a reduction of freight transport volumes due to this issue.

### 7.3. Changes in Operating Costs

A spreadsheet model was created to determine the cost effects of a trip time increase. In order to do so, the 1532 trains from the schedule sample (compare section on data and software) were grouped by distance and by train type. The distance attribute was divided into short (up to 300km), medium (300 to 700km) and long distance (above 700km); in industry practice, these distance segments have proven to be a practical and reasonable measure for rail trip planning.[13] The train type attributes included block trains, wagonload trains and combined transport, which are the different production systems introduced in chapter 5. Furthermore, the cargo type was provided in the schedule and the train types were assigned to them according to Table 11. Thus, the distance and the train type form a three by three matrix with nine cluster (compare table 12), that will be used throughout the entire analysis.

*Table 11: Train Type by Cargo*

| Cargo Type | Train Type (= Production System) |
|---|---|
| Container | Combined Transport |
| Auto | Block Train |
| Steel | Block Train |
| Cole | Block Train |
| Tank wagons | Wagonload Train |
| Unit Cargo | Wagonload Train |
| Aluminium Oxide | Block Train |
| Limestone | Block Train |
| Ore | Block Train |
| Aluminium | Block Train |
| Sulphur | Wagonload Train |
| Methanol | Wagonload Train |
| Phenol | Block Train |
| Bulk | Block Train |

As a result of the schedule dissemination, the following cluster distribution was counted:

*Table 12: Train Categorization of the Schedule Sample*

| | | Distance Segment | | |
|---|---|---|---|---|
| Train Type | **total** | long | medium | short |
| Wagonload Train | 333 | 85 | 52 | 196 |
| Block Train | 434 | 77 | 179 | 178 |
| Combined Transport | 765 | 316 | 91 | 358 |

[13] These intervals are used for consulting projects (e.g. with strategic and analytical content) at Railistics and in most cases comply with the assumptions of the customers.

| | | | | |
|---|---|---|---|---|
| | 1532 | 478 | 322 | 732 |

As no trip times were indicated in the schedules, they had to be estimated in order to calculate trip costs. With the help of DB Netz AG's Trassenfinder, a set of 15 relations is analysed and the average speed calculated by dividing the trip distance by the indicating driving time. Trips of the different distance were simulated in order to find an average speed indication under operational conditions, i.e. including stops, curves, gradients, etc. This yielded the following results for freight trains with no nightly speed limitation[14]:

*Table 13: Average Speed by Distance*

| Distance Segment | short | medium | long |
|---|---|---|---|
| Average Speed (km/h) | 50.8 | 54.5 | 54.8 |

The assumption that short-haul trains have a slightly lower average speed is realistic as acceleration and deceleration phases make up more of the total trip than for longer distances. These average values were multiplied with the distance to obtain a basic trip time. Additionally, penalties of 15 minutes per border crossing and 30 minutes per driver change were included. The number of border crossings is derived from the origin and destination data and driver changes were assumed to occur after a shift of 8 hours, i.e. the number is found by dividing the total trip hours by 8. The resulting total trip time was used to calculate the trip costs, which are comprised of the following elements:

- Locomotive costs
- Wagon costs
- Driver costs
- Energy costs
- Track access costs
- Marshalling / shunting costs.

The last two items on the list, track access charges and shunting costs, are independent of the speed and the duration of the trip. Despite them being constant, they are still part of the analysis, as they are part of the overall costs and therefore necessary for calculating the relative change in operating costs. This relative change (i.e. percentage change) is needed as an input variable for the modal shift calculation by multiplication with the elasticities.

[14] That these values are a realistic estimate is confirmed in an unrelated study carried out by the author on behalf of Railistics for the European Union as a client. This assignment required to monitor the average speed of freight trains on different European rail freight corridors, where departure and arrival times were provided by various operators. Results ranged from 48 km/h to 58 km/h depending on the respective corridors.

In the following the costs rates per cost element are described. The data were obtained from Railistics database and had been collected through various benchmarking projects as explained in chapter 6.2. All costs have been adapted to a 2019 price level using a consumer price index for the Netherlands obtained from the World Bank database (World Bank, 2019).
This part of the study is a financial analysis with the goal to identify the changes in operating costs for the freight rail operators. Therefore, the accounting costs are calculated, i.e. including the costs of capital, insurances and depreciation. Value-added taxes (VAT), however, are not included, as they are recoverable (European Commission, 2014). In the economic analysis following in the later chapters, other conditions have to be considered as compared to the financial analysis. These will be explained in the respective chapters.

### 7.3.1. Cost Rates for the Base Case

Locomotives: this cost element covers the procurement and upkeep of the locomotives, including depreciation, insurance and interest payments. As there is a large variety of different locomotives operating in Europe, the cost characteristics of a modern multi-system (i.e. suitable for cross-border operations between the Netherlands and neighbouring countries) electric locomotive were assumed, as these are the major traction provider in the almost completely electrified Dutch network. Shunting operations carried out with Diesel shunting equipment are neglected as they are generally taking place at low speed and will not be affected by a speed limit. Furthermore, different productivity levels were assumed and attributed to the distance classes. Accordingly, the following hourly rates for the different distance segments were calculated:

*Table 14: Locomotive Costs*
*Source: Railistics database*

| costs multi-system locomotive | | |
|---|---|---|
| investment costs | | 4,000,000 € |
| depreciation (a) | 25 years | 160,000 € |
| interest rate (b) | 3.0% | 120,000 € |
| insurance costs (c) | 1.1% | 44,000 € |
| maintenance costs (d) | 7.0% | 280,000 € |
| annual costs (e = a+b+c+d) | | 604,000 € |
| daily costs (f = e /365) | | 1,655 € |

| | productivity (hours / day) | costs per hour |
|---|---|---|
| short | 10 | 165.48 € |
| medium | 12 | 137.90 € |
| long | 16 | 103.42 € |

Wagons: the same approach was chosen for wagons. Like with locomotives, there is a large variety of different wagon types in use. DB Cargo AG[15] alone has a range of 176 different models in their portfolio (DB Cargo, 2019). Therefore, it was chosen to use a standard 60-foot container wagon to represent combined transport and a tank wagon for block trains. For wagonload trains, regular general cargo cars are used.[16] The hourly rates depending on the same productive hours are presented in Table 15.

*Table 15: Wagon Costs*
*Source: Railistics database*

| Wagon type | | Container wagon | Tank Wagon | General Cargo Wagon |
|---|---|---|---|---|
| purchase price | | 70,000 € | 110,000 € | 85,000 € |
| depreciation | 25 | 2,800 € | 4,400 € | 3,400 € |
| interest | 3,00% | 2,100 € | 3,300 € | 2,550 € |
| insurance | 1,10% | 770 € | 1,210 € | 935 € |
| maintenance | 7,00% | 4,900 € | 7,700 € | 5,950 € |
| annual costs | | 10,570 € | 16,610 € | 12,835 € |
| daily costs | 365 | 28.96 € | 45.51 € | 35.16 € |
| productivity (hours / day) | | | hourly costs | |
| short | 10 | 2.90 € | 4.55 € | 3.52 € |
| medium | 12 | 2.41 € | 3.79 € | 2.93 € |
| long | 16 | 1.81 € | 2.84 € | 2.20 € |

Driver costs: the driver costs were estimated to be 56.85€ per hour gross of income tax, taking into consideration days of absence, idling time reducing the staff productivity and pension benefits. It is assumed that one driver is sufficient to operate a modern locomotive.

*Table 16: Driver Costs*
*Source: Railistics database*

| | annual salary incl. employee on-costs | ø hourly rate | effective hourly rate |
|---|---|---|---|
| Driver 2019 | 55.000,00 € | 33,72 € | 56,20 € |
| Working days | 250 | | |
| Holidays | 30 | | |
| sick days | 10 | | |
| hours per day | 8 | | |
| Working hours per year | 1680 | | |
| productivity | 60% | | |
| pension benefits | 3% | | |

[15] DB Cargo AG is the freight subsidiary of Deutsche Bahn AG (DB AG). Although the name implies to abbreviate Deutsche Bahn as "DB", the name of the cargo unit actually is DB Cargo.
[16] Validated by two experts from the interviewee group as a common approach to construct price quotations to customers.

Energy costs: costs for electric current differ according to different train weights. The specific energy consumption in Kilowatt-hours (kWh) per kilometre for freight trains at different speeds has been simulated with DB Netz AG's online tool "Trassenfinder". The combined transport profile is also used for the wagonload train segment, as similar weights are assumed.

*Table 17: Specific Energy Consumption*
*Source: own calculation based on DB Netz AG's Trassenfinder*

| | CT/Wagonload profile | Block Train profile |
|---|---|---|
| Locomotive | Vectron (BR 193) | Vectron (BR 193) |
| Wagons | 19x container trailer | 30x open bulk trailer |
| Length | 397m | 442 m |
| Mass | 1,267 tons | 1,820 tons |
| | | |
| Energy consumption | kWh/km | kWh/km |
| 40 km/h | 7.9 | 10.7 |
| 60 km/h | 9.5 | 12.6 |
| 100 km/h | 13.2 | 18.0 |

In the Netherlands, ProRail as infrastructure provider charges 0.028105€ per kWh for the 2019 operating year (ProRail B.V., 2017). For distances travelled outside the Netherlands, a rate of 0,18€ per kWh charged by DB Netz were applied. The results show that energy consumption, and consequently costs, decrease with lower speed.

Track access charges: in the Netherlands, ProRail charges different rates for different train weights. The network statement indicates the following rates per train-kilometre for 2019:

*Table 18: Track Access Charges in the Netherlands*
*Source: ProRail B.V., 2017, p.94-96*

| Weight category of the train | per train-km | |
|---|---|---|
| up to 120 tons | 0.8513 € | |
| from 121 to 160 tons | 1.0652 € | |
| from 161 to 320 tons | 1.3492 € | |
| from 321 to 600 tons | 1.8852 € | |
| from 601 to 1,600 tons | 3.0191 € | *CT / wagonload* |
| from 1,601 to 3,000 tons | 3.6351 € | *block trains* |
| from 3,001 tons | 3.9432 € | |

Similar to the energy costs, wagonload trains and combined transport have been grouped together into the weight class from 601 tons to 1,600 tons. Block trains are grouped into the range of 1,601 to 3,000 tons.

For the sections outside the Netherlands, DB Netz AG's rate of 2.83 € per tkm for combined transport and wagonload trains has been applied and 3.06 € per tkm for block trains (Deutsche Bahn AG, 2018).

Marshalling and shunting: the Netherlands' most important place of loading and unloading is the port of Rotterdam. The port of Rotterdam consists of six deep-sea and three short-sea container terminals and container trains usually dock at three terminals before they are fully loaded. For each terminal service in Rotterdam, costs of 750 € are estimated and 300 € for hinterland terminals. Wagonload trains are typically fed into the system from factory sidings and delivered to a destination siding. Therefore, a shunting fee of 50 € per wagon per activity and an average number of 20 wagons per train is assumed.

*Table 19: Marshalling/Shunting Cost Assumptions*
*Source: Railistics Database*

| *Rotterdam harbour* | terminals served | |
|---|---|---|
| Block Train | 1 | 750 € |
| Combined Transport | 3 | 2.250 € |
| *hinterland* | terminals served | |
| Block Train | 1 | 300 € |
| Combined Transport | 1 | 300 € |
| | number of wagons | |
| Per wagon | 1 | 50 € |
| Wagonload Train | 20 | 1.000 € |

The following example shows the cost mix of a container train (combined transport) going from Rotterdam to Frankfurt/Oder, Germany, via the border crossing at Emmerich. The distance of 866 km at an average speed of 54.8 km/h yields a trip time of 16.9 hours including a penalty for the border crossing. Based on this and the cost rates indicated before, the time-dependent costs can be calculated as follows:

*Table 20: Example Calculation of Time-dependent Costs*

| | Cost rate/hour | Total[17] |
|---|---|---|
| Locomotive | 103.42 € | 1,747 € |
| Wagon | 60.70 € | 1,025 € |
| Driver | 66.15 € | 1,117 € |

[17] rounded

Concerning the costs for energy and track usage, the distance of 172 km on the Dutch and the 694 km on the German side are relevant. Lastly, the loading and shunting fees are added.

*Table 21: Example Calculation of Constant Costs*

| | | per kilometre | Total |
|---|---|---|---|
| Energy | NL | 0.37 € | 63 € |
| | DE | 2.38 € | 1,651 € |
| | | | 1,715 € |
| Track access | NL | 3.02 € | 519 € |
| | DE | 2.91 € | 2,019 € |
| | | | 2,538 € |
| Loading/Shunting Rotterdam | | | 2,250 € |
| Loading/Shunting Frankfurt/O. | | | 300 € |
| | | | 2,550 € |

Thus, total costs of 10,693 € accrue for a container train from Rotterdam to Frankfurt/Oder.

### 7.3.2. Cost Rates for Alternatives

As the maximum allowed speed is reduced, the driving time increases by 29 minutes in the case of 40 km/h and 12.4 minutes for 60 km/h allowed maximum speed. While most cost elements remain constant and increase linearly with driving time, energy consumption per kilometre decreases with slower driving as was shown in Table 17. Additionally, the interviewees indicated that if travel times increased to an extent that certain return cycles could not be kept employing the same train set for a new round-trip, additional locomotives and wagons had to be kept in reserve. It is hardly possible to quantify this incremental demand, as it depends on the single cycle design and the company's specific reserve fleet already on hand. Furthermore, the number of train sets in possession is a discrete variable and one operator would use an additional set for multiple connections in their network. However, as a minimum conservative estimation, a reserve equivalent to the time increment is added for short- and medium-haul trips; i.e., if trip time increases by 5%, an additional 5% locomotive and wagon costs are added as well. According to the interviews, the long-haul relations should have sufficient buffer to make the round-trip without an incremental number of train sets. Applying the new driving time and cost rates, the results change accordingly (column "base" refers to the calculated costs of the base case in tables Table 14 to Table 19):

*Table 22: Operating Cost Comparison for the Rotterdam – Frankfurt/Oder Example (rounded to full Euro)*

| | Base Case | 40km/h | | | 60 km/h | | |
|---|---|---|---|---|---|---|---|
| | | costs | difference vs. base | % change | costs | difference vs. base | % change |
| Locomotive Costs | 1.747 € | 1.803 € | 56 € | 3,2% | 1.770 € | 23 € | 1,3% |
| Wagon Costs | 1.026 € | 1.058 € | 32 € | 3,1% | 1.039 € | 13 € | 1,3% |
| Driver Costs | 1.118 € | 1.153 € | 35 € | 3,1% | 1.132 € | 14 € | 1,3% |
| Energy Costs | 1.713 € | 1.707 € | -6 € | -0,4% | 1.709 € | -4 € | -0,2% |
| Track access Costs | 2.539 € | 2.539 € | 0 € | 0,0% | 2.539 € | 0 € | 0,0% |
| Terminal/Marshalling | 2.550 € | 2.550 € | 0 € | 0,0% | 2.550 € | 0 € | 0,0% |
| **Total** | **10.693 €** | **10.810 €** | **117 €** | **1,09%** | **10.739 €** | **46 €** | **0,43%** |

As the specific energy consumption reduction for 40 and 60 km/h only applies to the 32km-segment of reduced speed, these savings are not sufficient to off-set the cost increases from other elements. The costs for rolling stock and personnel eradicate the gains by increasing at an equivalent rate.

### 7.4. Summary and Implications for Operating Costs: Answer to research sub-question 1

The exercise above has been carried out for the entire sample of 1532 trains and the results were aggregated in their respective train type and distance segments. Accordingly, the following cost implications have been found:

*Table 23: Costs per Train Kilometre (Base Case)*

| | long | medium | short |
|---|---|---|---|
| Wagonload Train | 11.08 € | 14.01 € | 22.40 € |
| Block Train | 11.19 € | 12.43 € | 15.86 € |
| Combined Transport | 11.01 € | 14.56 € | 19.37 € |

The costs per train kilometre as shown in Table 23 are plausible. Benchmarks indicate costs of 17.00€ - 21.50€ per train kilometre for combined transport container trains (Forschungsinformationssystem (FIS), 2018) and 15€ per train kilometre for freight trains in general (Fraunhofer ISI, 2013). Troche (2009) calculates costs for rail transport in Sweden. In a case study of wagonload trains, he finds costs of around 6,400 Swedish Crowns for a 990 km trip for two wagons. Converting this to Euros and assuming 25 wagons, this equals 15,17 € per train km. A generic cost model is used in a study by MDS Transmodal (2012) for coal block trains in Great Britain. They find costs of 6.89 British Pounds per tonne for a round trip of a total of 734 km and a net load of 1,330 tons. This equals 12.48 GBP per train km. Converted to Euros using an exchange rate of 1.25 Euros per Pound, which is realistic for the 2012/13 period, this equals to

EUR 15.60. In Germany, the revenues per train kilometer for state-owned enterprises was around 19.90 € and 14.60 € for privately-owned operators in 2015 (Bundesnetzagentur, 2016). This is not equal to the costs per train kilometer, but given the small profit margins in the industry, these values provide a good indication of the magnitude.

Average costs increase for alternative 1, the reduction to 40 km/h, between 0.4% on the long range and 5% on the short range.

*Table 24: Cost Increase for Alternative 1 (40km/h)*

| | long | medium | short |
|---|---|---|---|
| Wagonload Train | 0.4% | 1.6% | 2.8% |
| Block Train | 0.7% | 2.0% | 4.2% |
| Combined Transport | 0.9% | 1.8% | 5.0% |

For alternative 2, the reduction to 60 km/h, the cost increase is less significant.

*Table 25 Cost Increase for Alternative 2 (60km/h)*

| | long | medium | short |
|---|---|---|---|
| Wagonload Train | 0.4% | 0.9% | 1.4% |
| Block Train | 0.3% | 0.9% | 1.7% |
| Combined Transport | 0.4% | 0.8% | 2.1% |

These percentage increases in operating costs by distance segment and train type are the answer to research sub-question 1: What are the operational effects and the cost implications of a speed limit reduction on the railway freight operators?

They are important deliverables for the modal shift calculation within the scope of the cost-benefit analysis following in chapter 9. Multiplied with the elasticities derived from the interviews as outlined in section 8, the total shifting freight volume can be estimated.

# 8. Research Part 2: Demand Effects of Freight Transport in the Netherlands: Expert Interviews

The expert interviews serve the purpose of finding the case-specific elasticities and other operational implications of the speed limit reduction in order to answer research sub-question 2, estimating the demand effects between costs of rail transportation and road and waterway transportation in the region of interest with respect to train type and distance segment.

Therefore, managers from railway operators, forwarders and consignors were interviewed to ensure a wide market coverage. These conversations were made with key individuals with respect to modal choice, possessing all necessary information regarding costs and pricing. The managers were asked to estimate their customers' reaction towards a speed reduction and resulting cost and transport time increases. Based on their experience of past events and their knowledge about the competitive situation in the rail freight market, they will be able to estimate a loss of volume to other modes given time and price increases at different levels. These estimations will be asked for different distance categories (short-haul up to 300km, medium-haul between 300 and 700km, long-haul above 700km) and the three major production systems, which is closely related to the type of services they provide. Furthermore, their statements are the key to identify step costs with respect to the time-variable locomotive, wagon and driver costs, as was explained in section 7.3. These may occur when the available train sets no longer suffice to perform the round-trips as they are scheduled today or when new personnel are needed.

All interviews were conducted either at the respondent's office or in a neutral location, e.g. a café. The interviews were conducted either in English or in German while the interviewer took notes in the prepared questionnaire exclusively in English. The interviews were conducted by the author of the study, accompanied by a senior consultant from Railistics. This had two benefits: firstly, the experienced consultant was able to give valuable input to the discussions and secondly the consultant could steer the interviews into the right direction and maintain the discussion while the author could take notes simultaneously.

## 8.1. The Questionnaire

Three different questionnaires were prepared to match the interview partners, slightly adapting the content for railway operators, consignors and forwarders. The first section enquires about the respective firm's modal choice and general field of activity, such as the nature of the transported goods, the industry of activity, the most dominant shipment O-Ds and the train types used or operated mostly. For railway operators, the questions refer to their own operation, while for forwarders and consignors they refer to the transport services booked from railway operators.

In the second section, questions regarding the possibility and probability for changing the mode are asked. This part is most important for the quantitative assessment of the modal shift and elasticities, as it is asking for the expected shift of traffic volumes under varying cost increments for different distances and train types.

The third section is about the rolling stock operated or owned by the respective company. While ownership of rolling material is quite obvious for operators, also some forwarders and consignors possess wagons in order to reduce logistics costs. Furthermore, questions regarding track capacities are included.

The last section asks for a brief outlook to the future development of the railway sector.

The complete questionnaires are attached to the study in annex 3.

## 8.2. The Interviewees

The interviews were conducted with thirteen stakeholders from the railway industry. They were approached by telephone if they were interested to take part in the study. The participants were identified because they are contacts of Railistics from previous projects and considered relevant for the study. In three cases, ProRail established the contact between interviewer and interviewee. From the contacted companies, two parties declined the offer to answer; one of them because of the political sensitivity of the topic and one for practical reasons as no available employee felt suited to comment on this operational issue. The thirteen responding firms include consignors, railway operators, freight forwarders and one other expert.

### 8.2.1. Representativeness of the Sample

The responding railway operators cover more than 85% of the scheduled freight train kilometres driven in the Netherlands, including both state-owned and private companies. This was calculated based on the same schedule sample also used in section 7.3 to identify the cost implications. According to these data, the four railway operators produce a combined freight service of 36.1 million train kilometres out of a total of 42.8 million freight train kilometres on Dutch territory per annum.

Regarding forwarders from the combined transport segment, firms were interviewed with a cumulated transport performance of around 4 million moved container units (measured in Twenty-foot Equivalent Unit, TEU) across Europe. Their predominant field of action is the port hinterland traffic in central Europe, especially on the north-south-traverse from the Dutch, Belgian and German ports to southern destinations, but also offering connections to Spain, Poland or the Czech Republic. In the Netherlands, around 1.377 million TEU have been transported by rail in 2017 (OECD, 2019), while the total European volume amounted to 21.9 million TEU in the same year (BSL Transportation Consultants, 2019).

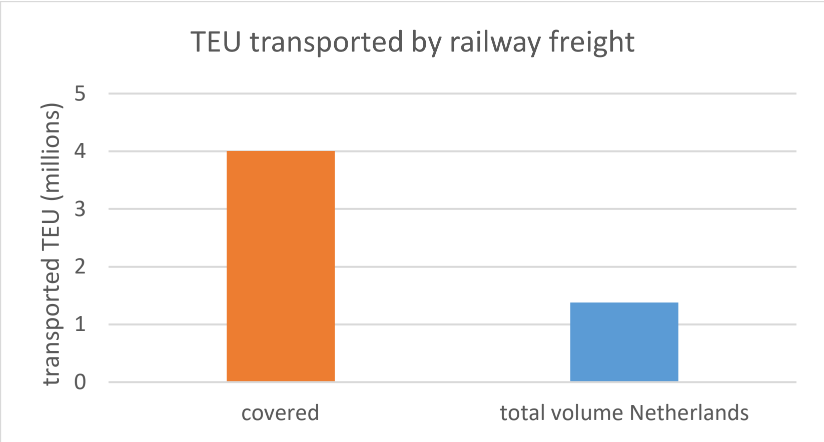


*Figure 20: Container Units (in TEU) Transported by Railway Freight*
*Source: OECD, 2019*

Amongst consignors, two companies each from the steel production and the chemical sector agreed to participate, both of which make use of the wagonload and block train segments. For all companies, the Netherlands are highly relevant as they either operate in the country or make use of the domestic railway network.

Additionally, a manager from a port authority, responsible for the rail-side infrastructure and business development, answered to the questions.

### 8.2.2. Description of the Interviewees

All questioned individuals hold a position in their respective company that makes them knowledgeable in the field as they are directly involved in freight railway planning or execution. Ranging from operations managers to logistics purchasing and managing directors, the choice of experts provides a profound expertise concerning operations and business administration. As the issue of differentiated driving is highly political and still not decided, all of the respondents requested to remain anonymous at any given point in the study. In the following, the interview partners are briefly introduced.

1. The respondent is the contract manager and purchaser for railway services on behalf of a large steel company in the Netherlands. Raw materials, mostly coal, ore and chalk, are imported from neighbouring countries and the seaports by railway. Outbound products, mainly steel coils for the automobile industry and other steel products, too, are transported by train to neighbouring countries or the seaports.
2. The respondent is the head of operations with an Austrian steel plant's logistics subsidiary exclusively operating for the parent company. The respondent's duties include managing the own rolling stock, planning outbound and inbound transports, as well as purchasing transport services from third parties if required. The company's transports include train and barge connections to the North Sea ports along the Rhine and Danube rivers.
3. The respondent is a Dutch chemical plant's business developer responsible for logistics and transport projects. This includes cost management and supply chain planning for train and barge transport of dangerous goods, mostly liquid or gaseous materials in tank carts.
4. The respondent is the supply chain manager for a different chemical company in the Netherlands. Similar to respondent number 3, tank wagons filled with chemicals are moved in wagon groups or full block trains from the company's site to suppliers, customers or the port and vice versa.
5. The respondent was head of operations with a container forwarder in the combined transport segment. As such, the respondent is experienced in customer behaviour and the demand effect of operational restrictions like a speed limit. The company specializes in container shuttles from the large terminals to distribution hubs in the European hinterland.
6. The respondent is the managing director of a company offering multi-modal container transport solutions. The company, headquartered in Duisburg, Germany, operates own container terminals for barges, railways and trucks. These terminals are scattered along the Rhine, on both the German and Dutch part of the river. With regards to railway freight, the company's strategy is to buy entire train capacities from the railway operators including rolling stock, personnel and trip organization. They then market single container slots to their customers working as an intermediary between consignors and railway operators.
7. The respondent is the former managing director of the Dutch section of a European freight railway operator. The company's portfolio includes all train types and distance segments across the Netherlands into the harbour hinterland of neighbouring countries. The company's wagonload system is the largest in Europe.
8. The respondent is a railway operator's head of operations for the Dutch and German markets. The company is the Dutch subsidiary of an international logistics group and operates cross-border hub-to-hub container services as well as block train services.

9. The respondent is the managing director of a railway operator based in the Netherlands offering bulk, liquids and general cargo transports by rail after having started as a provider specialized in container transports.
10. The respondent is concerned with daily operations management with a railway operator. As the supervisor of transport planning and offer management, the respondent is very knowledgeable with regard to pricing and price negotiations. The company is originally Austrian, but the respondent is based at the Dutch operations office in Rotterdam.
11. The respondent is the founding partner of a railway operator and forwarder that focuses on transport of fast-moving consumer goods and fresh products. With the company being in the start-up stages, the respondent is responsible for various tasks including sales and costing. Prior to his current position, the respondent was the managing director of a company specializing in rolling-stock rentals and traction provision.
12. The respondent is the managing director of a Dutch railway operator. The company's portfolio includes all train types and distance segments across the Netherlands into the harbour hinterland of neighbouring countries. The company's wagonload system is the largest in Europe.
13. The respondent is a business developer for a seaport on the Dutch coast. In that role, the respondent is responsible for providing attractive rail infrastructure and cost conditions so that cargo (both inbound and outbound) can be hauled by rail efficiently. Thus, the effects of cost changes (e.g. for container handling or port-side track access) are well-known.

Table 26 summarizes the set of respondents and their competence with respect to the train type segments.

*Table 26: Respondents in the Study*

| No. | Type | Company type | Position | BT | CT | WL |
|---|---|---|---|---|---|---|
| 1 | CO | steel company | Contract Manager Rail Logistics | X | | X |
| 2 | CO | steel company's logistics subsidiary | Head of Operations | X | | X |
| 3 | CO | chemical plant | Innovation & Business Development | X | | X |
| 4 | CO | chemical plant | Supply Chain Manager | X | | X |
| 5 | FW | CT forwarder | Head of Operations | | X | |
| 6 | FW | CT forwarder | Managing Director | | X | |
| 7 | RO | railway operator | Former Managing Director | X | X | X |
| 8 | RO | railway operator | Head of Operations NL & DE | X | X | X |
| 9 | RO | railway operator | Managing Director | X | X | |
| 10 | RO | railway operator | Operations Supervisor | X | X | X |
| 11 | RO, FW | express and fresh products | Founding Partner | | X | |
| 12 | RO, FW | railway operator, forwarder | Managing Director | X | X | X |
| 13 | O | harbour business development | Program Manager Rail | X | X | |

*CO = consignor, FW = forwarder, RO = railway operator, O = other*
*BT = block trains, CT = combined transport, WL = wagonload trains*

## 8.3. Results

This section presents the main results from the interviews. The first sub-section summarizes the relevant qualitative statements, before the quantitative results follow in the second sub-section. The latter are relevant to determine the elasticities and the modal shift caused by the higher operating costs.

In general, there was an ambivalent attitude of the interviewees towards the meetings. Some respondents were open-minded and rather curious. Their intention was to gather information themselves about the plans in the hope that the interviewing consultants had news to share. On the other side, on two occasions the interviewers were met with an almost hostile atmosphere. In the talks it turned out that the respective respondents believed the consultants to work on behalf of the ministry instead of carrying out independent research, with the purpose to defend and lobby for the new policy. Only after a careful explanation that it was the aim to make an economic assessment of differentiated driving did the respondents' attitude lighten up and the conversation proceeded in a cooperative manner. In most cases, uncertainty and to some extent concerns were encountered, as the speed reduction measure potentially hampers the railway freight industry.

All in all, the interviews proved to be a valuable and fruitful exchange. No conversation lasted for less than 90 minutes, with the longest meeting reaching almost 150 minutes.

### 8.3.1. Qualitative Results

In general, the topic was perceived as a highly political issue. The respondents seemed to be careful regarding their statements and the consequences their involvement might have. Accordingly, numerous interview requests were denied or not answered at all. Likewise, the interview partners were careful to not disclose operational data, such as individual transport costs or profits. Therefore, the nature of the interviews was rather qualitative and quantitative information were often kept to the required minimum for the study, namely the expected modal shift. However, it must be stated that no interview partner has a dedicated traffic distribution model at their disposal, so that all modal shift estimates are based on experience and the best judgement of the interview partners.

Generally, the respondents indicated that there was fierce price competition in the continental transportation industry. Especially the group of railway operators provided valuable insight into the difference between the different production systems. Containerized transport is standardized in such a way that the available modes are perfect substitutes, only differing in costs and time, but not in service. Therefore, the availability of railway or waterway infrastructure determines if there is a viable alternative to the dominant solution of trucking. Consequently, a shift to road transport occurs more easily than for block or wagonload trains. The two latter are a little more resistant to price increases, as the nature of the cargo is more suitable for rail transport. The high volumes and weights of bulky or liquid goods match the freight rail's capabilities, thus generating a cost advantage. Only barges manage to be even cheaper, provided that there is a suitable infrastructure available in an acceptable proximity to the sites of loading and unloading. The consignors, for example, agreed that most of the bulky and specially regulated dangerous goods are not suitable for road transport and therefore rail is frequently the only alternative.

The most important qualitative statements may not have been stated verbatim in every interview, but have been found to be similar across different meetings. As the core statements are quite similar, they are grouped as indicated in Table 27.

The numbered rows represent the respondents equivalent to their introduction and the respective summary in Table 26.

*Table 27: Qualitative Results Summary*

| Statement | Consignors | | | | Forwarders | | Railway Operator | | | | FW + RO[18] | | Other | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Competition-related Statements** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | % |
| The shorter the route, the more likely a change to road transport is, as barge transport becomes viable over longer distances due to its high fixed costs | | | x | | x | x | | x | | x | x | x | | 54% |
| Dangerous goods and bulk items transported by block trains are often not suitable for road transport. Therefore, ships often are the only alternative | x | x | x | x | | | x | x | x | x | | x | x | 77% |
| If a feasible waterway connection is available, the goods are mostly already transported by barge | x | x | | | | x | x | | x | x | | x | | 54% |
| A shift to road can happen very quickly and road transport operators can adapt supply quickly, but the full shift will not happen in the first year | | | | | x | x | x | | x | x | x | x | | 54% |
| A shift to barges would start slowly as it is restricted by capacity and take two to three years | x | x | | x | | | | | | | | | x | 31% |
| Wagonload transports are small in quantities and cannot compile a block train. Therefore, also filling an entire barge is not economically feasible. Hence, if there is a shift, it is towards trucks. | | | x | x | | | | x | | | | x | | 31% |

[18] Combined forwarding and railway operation activities

| Statement | Consignors | | | | Forwarders | | Railway Operator | | | | FW + RO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cost-related statements** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | % |
| Costs increase significantly when additional equipment or driver shifts are required | | | | | | | x | x | x | x | | x | | 38% |
| The shorter the distance, the more sensitive the production system is to cost increases | | | | x | x | x | x | x | x | x | x | x | | 69% |
| The combined transport is much more sensitive than the other segments with respect to costs. Competition is much tighter and users are more prone to switching | | | | | | | x | x | x | x | | x | x | 46% |
| In container transport, competition happens on a cent-per-tonne-kilometre basis | | | | | x | x | x | | x | | x | x | | 46% |
| Private railway operators achieve profit margins of 5% maximum, meaning that cost increases can quickly lead to termination of services | | | | | | | x | | | x | | x | | 23% |
| Cost increases of 1-2% can be passed on to customers, everything above this will have consequences for customers' modal choice | | | | | | | x | x | | x | x | x | | 38% |
| Short-haul shuttle trains in combined transport cannot bear more than 10% before complete termination | | | | | x | | | x | | x | x | x | | 38% |

| Statement | Consignors | | | | Forwarders | | Railway Operator | | | | FW + RO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Time-related statements** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | % |
| Bulk goods are not time sensitive, but rather costs sensitive. Thus, they are already transported by ship, if the origin-destination locations allow it | x | x | | | | | x | x | | | | | x | 38% |
| Pure driving time increases of less than an hour do no matter that much if the logistics chain can be adapted. Related cost increases are the issue. | x | x | x | x | | x | | x | x | | | x | | 62% |
| If driving times increase, operators need to back up at least the proportional amount of rolling stock | x | | | | x | | x | x | | x | | x | | 46% |
| Mostly, time buffers exist in container terminals, as forwarders who pick up the containers seek to avoid waiting times | | | | | x | x | | x | | x | | x | x | 46% |

### 8.3.2. Quantitative Results

As the majority of the interviewees indicated that a driving time increase of the determined magnitude was rather irrelevant and could be compensated by available buffers and operations planning, no effects were included in the modal shift model. Additionally, respondent 5 indicated that their international train services had a punctuality threshold of 60 minutes, meaning that an actual arrival of one hour after scheduled arrival was still considered on time. Therefore, the shift of traffic is based on the cost increases due to longer travelling times.
The assumptions stated in the interviews about the modal shift under certain cost increases were collected and transferred to a spreadsheet table as shown in the example for combined transport trains below.

*Table 28: Example of a Modal Shift Table*

| | Traffic shift in % by distance segment | | |
|---|---|---|---|
| Cost increase in % | Short | Medium | Long |
| 1% | 0.0% | 0.0% | 0.0% |
| 2% | 3.5% | 0.0% | 0.0% |
| 5% | 10.0% | 5.0% | 5.0% |
| 10% | 17.5% | 15.0% | 12.5% |
| 15% | 25.0% | 22.5% | 20.0% |
| 20% | 37.5% | 35.0% | 27.5% |
| 30% | 66.6% | 50.0% | 35.0% |

From the 13 interviews, one table per train type was obtained, if the respondent's firm operates this specific type. The statements made regarding the train types is shown in the last three columns of Table 26. Figure 21 shows the steps how the single interview results translate into the final modal shift estimates.


*Figure 21: Steps to Calculate the Elasticity Parameters*

In order to find the elasticity, the traffic shift is divided by the respective cost increase. In the example of combined transport in Table 28, a cost increase of 2% leads to a modal shift of 3.5% on short relations, which equals an elasticity of 1.75. Applying this calculation to the example table yields the following price elasticities.

For combined transport:

*Table 29: Example of an Elasticity Chart*

| | price elasticities | | |
|---|---|---|---|
| Cost increase in % | Short | Medium | Long |
| 1.0% | 0.00 | 0.00 | 0.00 |
| 2.0% | 1.75 | 0.00 | 0.00 |
| 5.0% | 2.00 | 1.00 | 1.00 |
| 10.0% | 1.75 | 1.50 | 1.25 |
| 15.0% | 1.67 | 1.50 | 1.33 |
| 20.0% | 1.88 | 1.75 | 1.38 |
| 30.0% | 2.22 | 1.67 | 1.17 |

These elasticities, however, are too coarse for the cost increases found in Table 24 and Table 25. For example, a cost increase of 3.5% could not be read off from the table. Therefore, a regression analysis was conducted for all nine cases, so that every possible result from the cost analysis can be translated into a modal shift scenario. In the regression, the cost increase in percent is the independent variable and the respective elasticity is the dependent variable in the following form:

$$Y = \alpha + \beta * X \tag{1}$$

with

Y = dependent variable, in this case the elasticity

$\alpha$ = constant term

$\beta$ = slope of the regression

X = independent variable, in this case the cost increase in percent.

The following results were obtained from the nine regressions:

*Table 30: Regression Results for the Elasticity Calculation*

| | | Combined Transport | Block Trains | Wagonload Trains |
|---|---|---|---|---|
| short | α | 1.297 | 1.053 | 1.105 |
| | β | 4.824 | 5.428 | 3.051 |
| medium | α | 0.640 | 0.299 | 0.773 |
| | β | 5.315 | 3.679 | 2.156 |
| long | α | 0.523 | 0.305 | 0.154 |
| | β | 4.261 | 3.625 | 4.067 |

Applying these regression results to a cost increase scale of 0% to 30%, which was also the range of the questionnaire, the graphical depiction shows that the elasticities increase and thus the modal shift is progressive with increasing costs. It must be stated that the elasticities in the scope of this study are only applicable to a cost increase (i.e. reducing railway freight traffic) and not to a cost decrease (which would attract new volumes). This is because a reduction from a higher to a lower value yields a different percentage change than an equal change in absolute terms in the other direction. Therefore, all elasticities mentioned in the following actually have a negative sign, but for simplicity they are expressed in absolute terms.

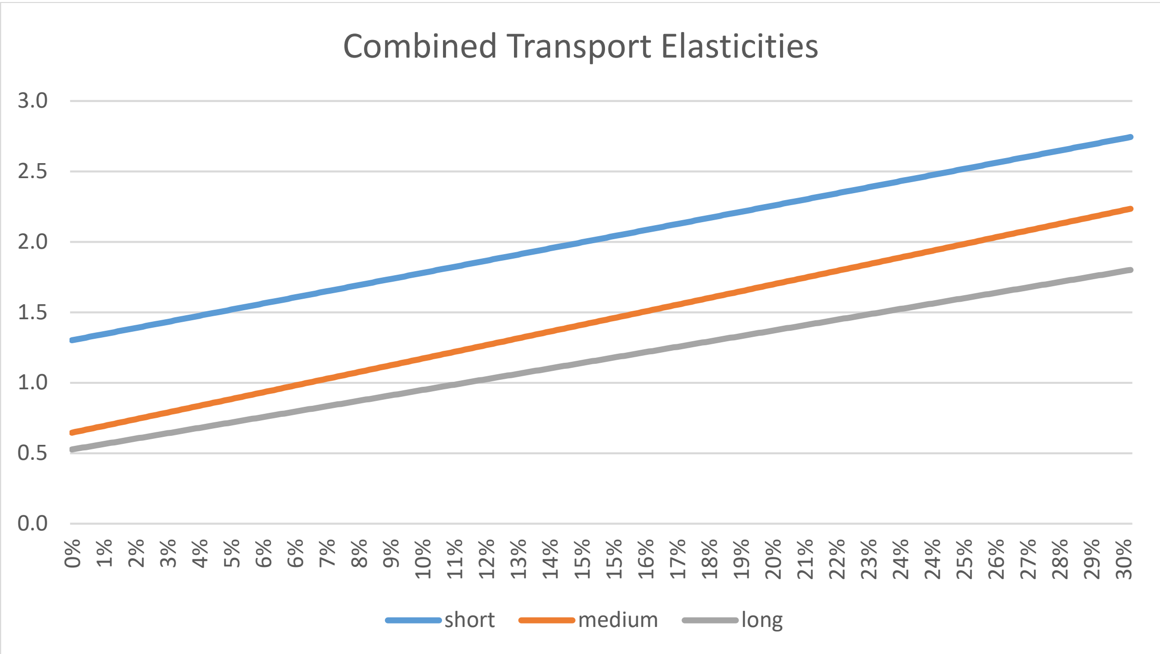


*Figure 22: Elasticities for Combined Transport*

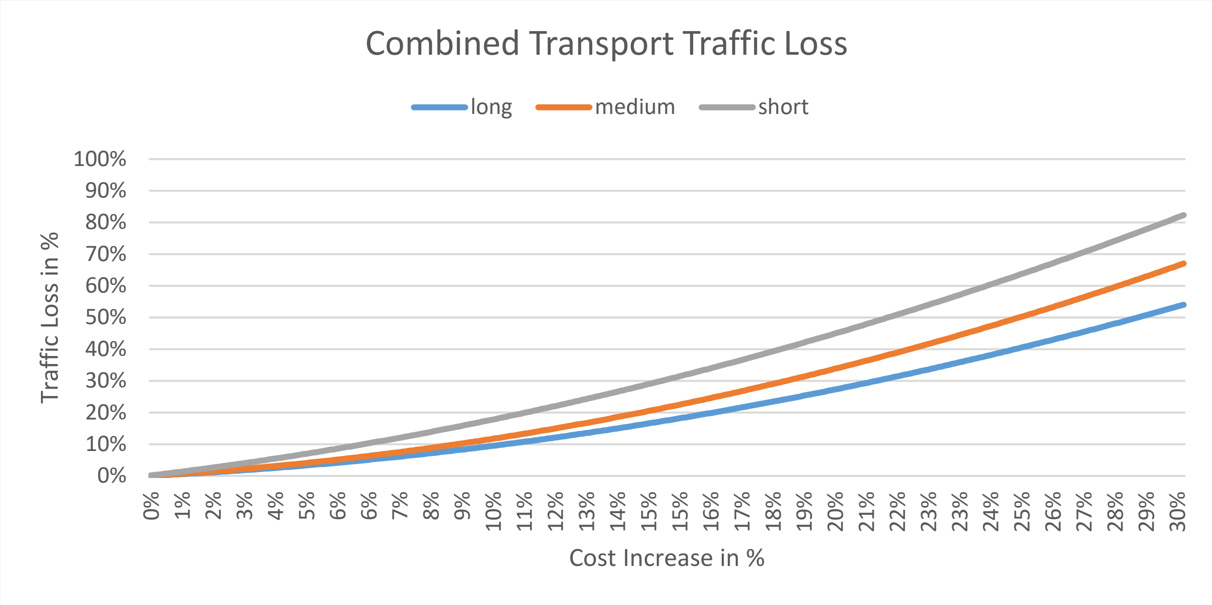


*Figure 23: Modal Shift for Combined Transport*


*Figure 24: Elasticities for Block Trains*

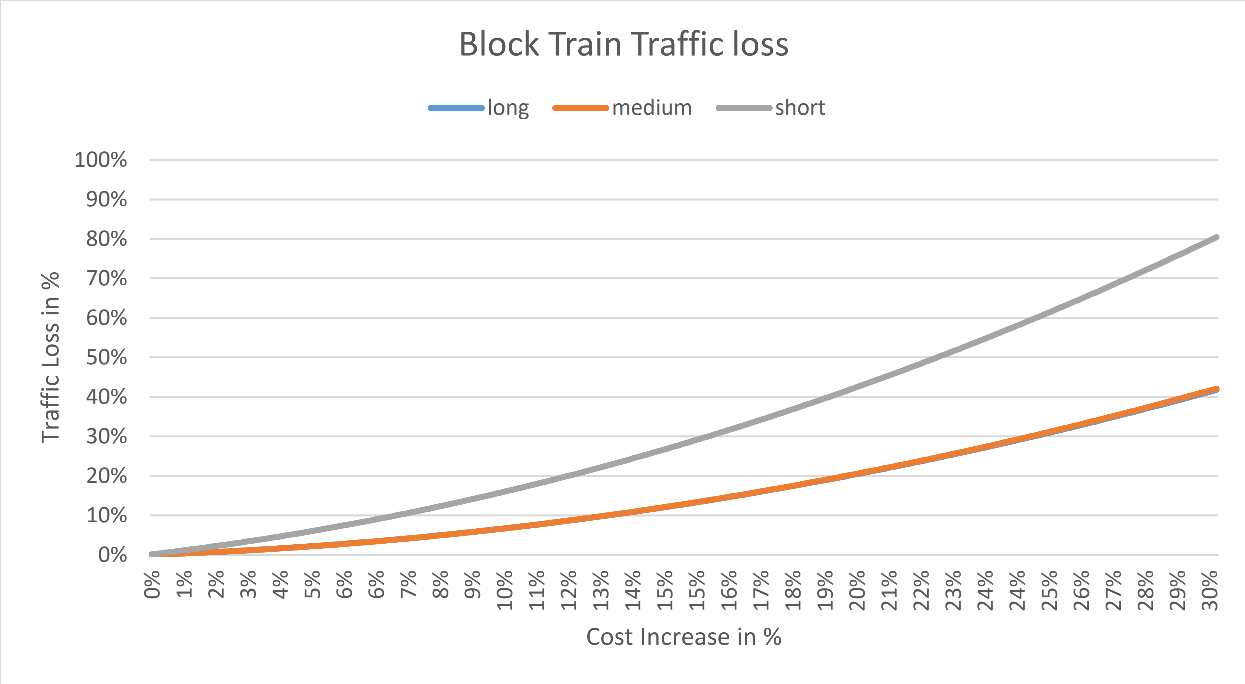


*Figure 25: Modal Shift for Block Trains*

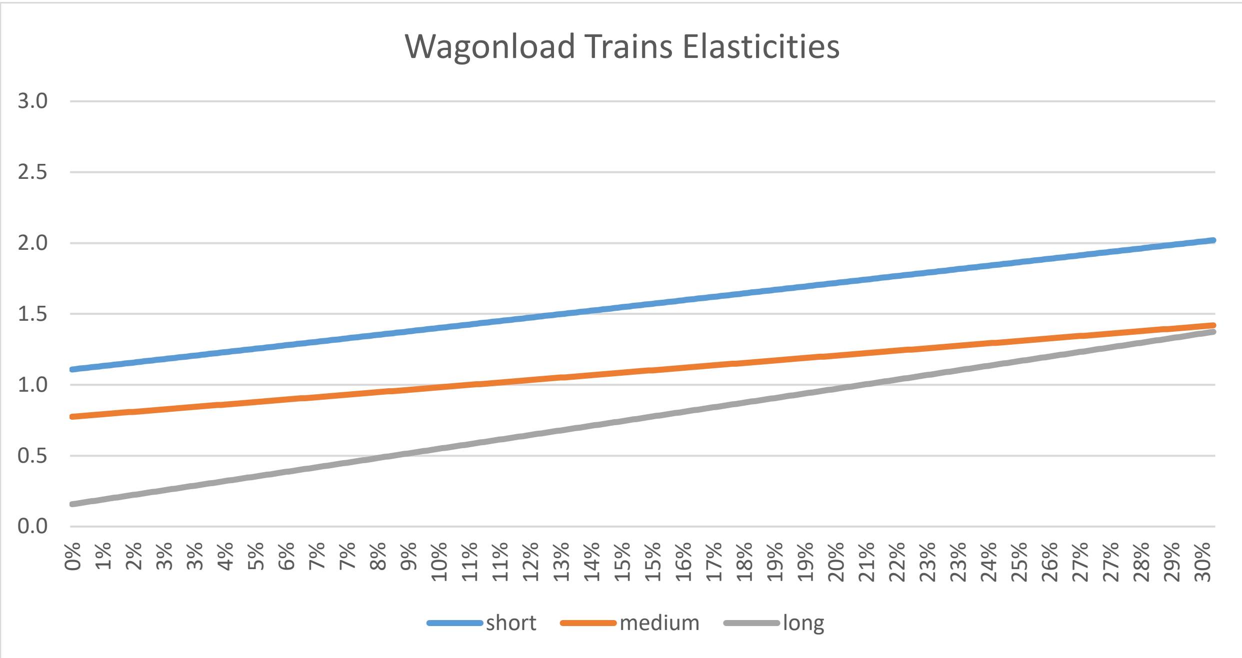


*Figure 26: Elasticities for Wagonload Trains*

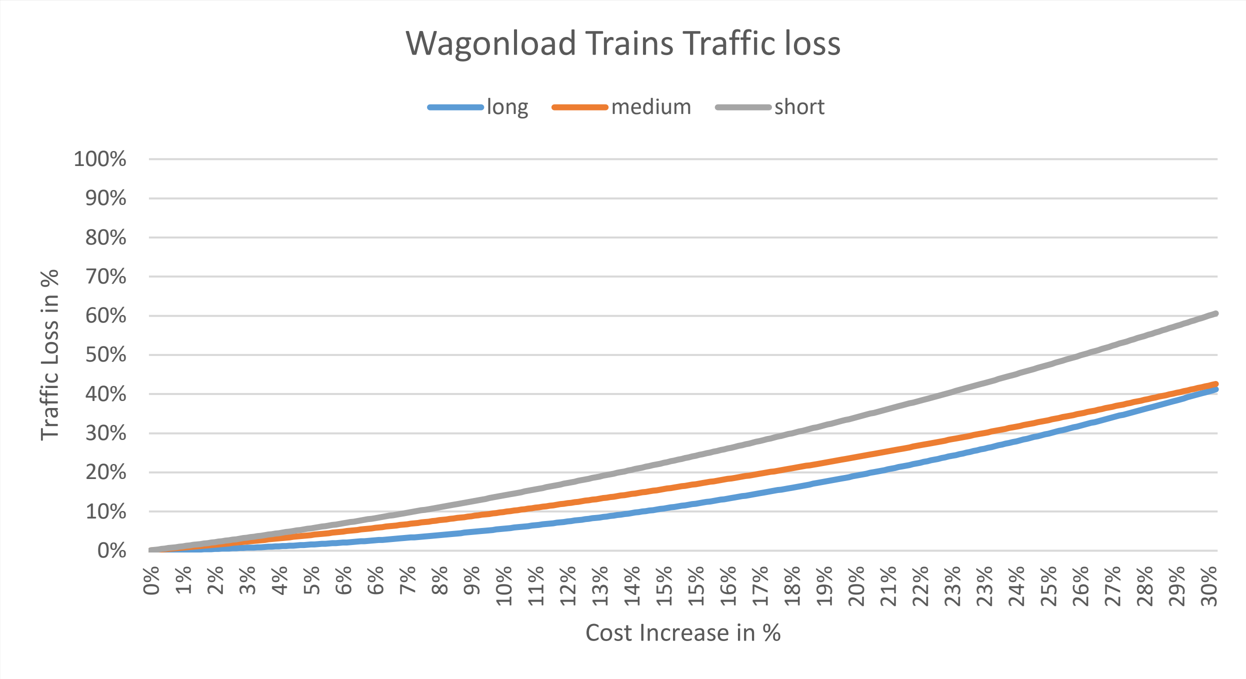


*Figure 27: Modal Shift for Wagonload Trains*

The graphs show that the combined transport segment reacts most sensitively to cost changes. This result is consistent with the assumption that price competition is much fiercer in this segment, as intermodal containers can easily be switched between modes. Opposed to that, heavy, bulky goods or those with special requirements cannot be transferred that easily and the modal shift sets in more moderately. Furthermore, for all train types, shorter connections are more prone to losing traffic than longer connections. In the block trains system, hardly any variances between long- and medium-haul services can be seen.

The fact that these elasticities are not constant intuitively makes sense. This implies that as costs increase only moderately, affected decision makers are rather hesitant to change modes. For example, a change of a percentage point from 1% cost increase to 2% is not causing as much modal shift as an increase from 9% to 10%. This might be because at lower ranges, firms are waiting to see where the market development goes, whereas a cost increase of 10% will instantly trigger decision makers to opt for the alternative.

Also in terms of magnitude the results presented in the elasticity figures above are realistic, comparing them to the results found in the literature review. Lewis and Widup (1982), for example, estimated rail demand elasticities between -0.92 and -1.02. Abdelwahab & Sargious (1992) indicated that elasticities for rail were between -2.19 and -0.75, thus also presenting a wide range. Likewise, De Jong (2003), studying the effect of transport costs on tonne kilometres across Belgium, Italy, Norway and Sweden, concluded that demand for rail transportation was very elastic (-1.40 to -3.87), which is similar to the results presented in this study. Jourquin, Tavasszy and Duan (2014) look at a European Network modelling the effects of a 5% increase in road transport costs of pre-haulage and post-haulage of the rail freight service, thus being a study that specifies the actual cost increase. The resulting increase in rail activity implies elasticities of 0.54 to 0.98. The focus of their work was the influence of pre-haulage and post-haulage distances on the main leg of the freight service. These result are very similar to the long- and-medium-range results for combined transport that usually requires these pre- and post-haulage service. Concluding, the presented results are in a realistic scale and are taken forward in this study.

With respect to the statistical relevance, the models offer good results. Depending on the area of business of the respondents and if estimates on all production systems could be made, the number of observations varies between 56 and 70. In all cases, the models can be considered valid, as the significance value of F are close to zero and valid at the 5% level. Technically speaking, the Significance F-value is the probability that the null hypothesis is not rejected. In this case, the null hypothesis is that all coefficients are unequal to zero. In other words, it is highly probably that the coefficients are not zero. Likewise, the p-values of the respective intercepts and variables are close to zero and therefore statistically reliable.

However, the $R^2$ values of the models range between 0.106 and 0.571. The $R^2$ value indicates how much of the change in the dependent variable (i.e. the modal shift) is actually explained by a variation in the independent variable (i.e. the cost increase). An $R^2$ of 0.106 thus says that only 10.6% of the variation in the modal shift is explained by the variation in the costs.

*Table 31: Regression Statistics for Combined Transport Trains*

| Combined Transport | Observations | $R^2$ | Significance F-value | Intercept p-value | Variable p-value |
|---|---|---|---|---|---|
| Short | 63 | 0.259 | 0.000 | 0.000 | 0.000 |
| Medium | 63 | 0.413 | 0.000 | 0.000 | 0.000 |
| Long | 63 | 0.365 | 0.000 | 0.000 | 0.000 |

*Table 32: Regression Statistics for Block Trains*

| Block Trains | Observations | $R^2$ | Significance F-value | Intercept p-value | Variable p-value |
|---|---|---|---|---|---|
| Short | 70 | 0.228 | 0.000 | 0.000 | 0.000 |
| Medium | 63 | 0.473 | 0.000 | 0.000 | 0.000 |
| Long | 70 | 0.482 | 0.000 | 0.000 | 0.000 |

*Table 33: Regression Statistics for Wagonload Trains*

| Wagonload Trains | Observations | $R^2$ | Significance F-value | Intercept p-value | Variable p-value |
|---|---|---|---|---|---|
| Short | 56 | 0.130 | 0.006 | 0.000 | 0.006 |
| Medium | 56 | 0.106 | 0.014 | 0.000 | 0.014 |
| Long | 56 | 0.571 | 0.000 | 0.042 | 0.000 |

Regarding the question as to where volumes will shift to, qualitative information from the interviews are adapted in the model. Accordingly, tonnage from block trains cannot be shifted towards road transport. It is either not feasible to load such heavy loads onto trucks and in the case of dangerous goods it might not even be allowed. Thus, it is assumed that goods previously transported by block trains will shift to barges. Tonnage from wagonload trains is generally considered too small in quantities to be feasibly shifted to waterway transport. Thus, the target mode is road transport. With respect to combined transport, no clear assumption can be made. Both road and waterway transport are feasible options, as today's modal split shows. Approximately 47% of hinterland container transport originating from Rotterdam harbour is carried by truck, while 40% are transported by barge (Klotz, 2015). This is equivalent to a ratio of 1.175:1 and, accordingly, 54% of the volume shifting away from combined transport trains is diverted to trucks and 46% to barges.

However, according to the interviews, only a portion of the shift will occur in the first year after the implementation of the speed limit, as available capacities are not sufficient to accommodate the new demand and supply does not adapt instantaneously. Road transport can adapt quite quickly as entry barriers to the industry are considered quite low. Especially from Eastern Europe, new players quickly create new capacities so that a shift to road would be completed in the second year after the introduction of the speed limit. Thus it is assumed that 50% of the shift will occur in year 0, and the remaining 50% in year 1 after the implementation of the new policy.

The situation in the inland waterway transport business is even less flexible, as high investment costs and regulations prevent instantaneous market entry and expansion of supply. According to the interviews, it would take 2-3 years for the modal shift to be completed. Thus, it is assumed half of the shift will occur in the year 1 and half in year 2. The total shifting traffic volumes are therefore distributed according to the following allocation key (where the numbers do not add up to 100%, the remaining portion remains with rail):

*Table 34: Modal Shift Allocation Key*

| **Year 0** | to barge | to truck |
|---|---|---|
| Wagonload | 0% | 50% |
| Block Train | 0% | 0% |
| CT | 0% | 27.0% |
| **Year 1** | to barge | to truck |
| Wagonload | 0% | 100% |
| Block Train | 50% | 0% |
| CT | 23.0% | 54.0% |
| **Year 2 and following** | to barge | to truck |
| Wagonload | 0% | 100% |
| Block Train | 100% | 0% |
| CT | 46.0% | 54.0% |

The quantitative results from the interviews are an essential part of the economic cost-benefit analysis and will be used to determine the modal shift in the following chapter.

### 8.3.3. Further Considerations

During the interviews, further interesting issues were mentioned that are relevant to the railway freight industry. It was considered worthwhile to present them in a dedicated section for future reference, as these issues could become relevant if the differentiated driving policy is pursued.
One key concern repeatedly expressed is the current lack of locomotive drivers, which could potentially aggravate. Railway operators have experienced drivers being lured by competitors with financial incentives as these specialized workers are so scarce. Especially in cross-border operations and different to regular truck licences, drivers need to possess the domestic accreditations for all countries they pass. Otherwise, drivers would have to be changed at the border. From the driver, this requires also to master the respective languages to a good degree, as English has not yet become the universal language of the railway system, as for example is the case with aviation. Due to these entry barriers, drivers are scarce and expensive. With a further increase in travel time, the demand for this sought-after resource is likely to increase even more, possibly creating severe bottlenecks.
Some ten years ago, the same Ministry now commissioning the differentiated driving study, campaigned for new wagon order regulations. In order to mitigate the risk from rail accidents involving dangerous goods, wagons should have been queued in a specific order so as to reduce the risk of mutual ignition, e.g. through a chemical reaction of gaseous and liquid flammables. This initiative could be refuted by the industry, as it would have caused very high costs caused by

additional shunting and train assembly activities. These costs would have exceeded the benefits of a risk reduction. The respondents indicated that this example should serve as a case to learn from and that similar unrest should be avoided this time. Before the ministry orders a test ride, a more in-depth consultation of all stakeholders and a detailed analysis should be conducted.

The most pressing issue was that a pilot such as the one following later in 2019 will have a signalling effect for other regions. The Meteren – Boxtel area is not the only region complaining about railway noise and if a pilot is conducted, other regions might follow suit and introduce a similar movement themselves. Potential first followers would be the German Rhine Valley region, the urban areas of Brabant (Eindhoven, Tilburg, Breda) or the Ruhr area. In this case, the railway system would be severely impeded and no longer able to compete with other modes.

Regarding the current climate change debate, the differentiated driving approach caused a lot of incomprehension. Railways are considered among the environmentally friendliest modes and artificially limiting its capabilities is in direct opposition to emission targets set by all kinds of public entities, notably the EU. Quite on the contrary, the interview partners demanded a more railway-oriented attitude, for example when it comes to public spending or taxation.

## 8.4. Summary: Answer to research sub-question 2

The most important findings are that all respondents expect a modal shift to occur. The respondents agree that the combined transport will react the most sensitively among the three systems due to the high cost pressure from trucks.  Likewise, the shorter the distance, the higher the likelihood that a modal shift will occur, as railways have a cost advantage over longer distances where economies of scale materialize. With respect to inland waterway transportation, there is consensus that where barges are a feasibly option, they are mostly the mode of choice already today and that consignments of the wagonload system are too small in size to be transported by barges. Therefore, only quantities from block trains and a share of the container load will shift to waterway transport.

Research sub-question 2 concerns the demand effects, i.e. the elasticities, between costs of rail transportation and road and waterway transportation in the Netherlands. The elasticities found in sub-section 3.2 reflect the findings above and range from just above 0 to around 2.6, depending on the production system and the transport distances. Within this range, the elasticities progress with the respective estimated cost increase. To conclude, the elasticities are in a realistic magnitude compared to the values found in the literature review. At the expected cost increase ranges, an elastic reaction of the demand side is expected.

# 9. Research Part 3: Economic Evaluation: Meteren-Boxtel Case Study

In this section, the results from the generic part, including the cost model, the expert interviews and the elasticity calculations, are transferred to the Meteren – Boxtel case study. The economic cost-benefit analysis is a method to determine the total cost and benefit that a certain undertaking brings to society as a whole. This method is used especially in the appraisal of transport and infrastructure projects, as these require substantial amounts of public funding and affect a wide array of stakeholders. The intention is to capture all costs and benefits and determine whether the policy intervention under investigation is – for the entire economy – adding value in excess of its costs. Costs are, for example, higher operating costs for rail or road users or changing maintenance costs. But also non-market items, i.e. things that cannot be traded, must be taken into account. This includes, for example, leisure time, air quality or noise emissions. In this chapter, these effects stemming from the change in operating conditions and traffic volumes between the years 2030 and 2040 are summarized and weighed against each other on a yearly basis[19]. This exercise is carried out for the two project alternatives, which are then compared to the null alternative. For the latter, no calculations are required, as no changes in any of the parameters will occur.

The results from the generic part, including the cost model, the expert interviews and the elasticity calculations, are transferred to the Meteren – Boxtel case study. After an introduction to the spatial situation and operational assumptions, the modal shift calculation follows in sub-sections 2 and 3. In its structure, this chapter follows the EU's CBA guidelines. Following sections on the context (sub-section 1) and the objectives (sub-section 2) of the policy change, an analysis concerning the demand and the modal shift is conducted in sub-section 3. This is followed by an overview of the project costs (sub-section 4) and a comprehensive economic analysis in sub-section 5. A summary including the calculation of key performance indicators and a sensitivity analysis in sub-section 6 concludes the chapter.

[19] The time line was determined by ProRail B.V. as a request in the project tender in order to be in line with the institution's internal planning processes and traffic forecasts.

## 9.1. Context of the Case Study

The segment between Meteren and Boxtel is part of the connecting line between the northern and western industrial and port areas of the Netherlands and the southern and eastern border crossings at Venlo and Emmerich, mainly into Germany. Due to the strong production and import/export activities around cities like Rotterdam or Amsterdam, this link is an important section of the main Dutch railway freight network (see Figure 1). Although the Betuwe rail line (the central East-West link between Zevenaar and Rotterdam) is a major freight-only rail corridor, the Meteren-Boxtel segment serves as a North-South connector to and from this line. Especially the functions as a transition link to the Brabant route (the southern East-West link between Venlo and Rotterdam) is important when the flow of trains on the two main lines needs to be balanced. The corridor also plays a bigger role as a link between greater Amsterdam and the Limburg area (chemicals), towards Antwerp, further into Belgium (steel industry) and France[20].

The segment starts just north of the Waal River across from Zaltbommel and heading south. After crossing the Maas River, the line runs through the municipalities of ‘s-Hertogenbosch and Vught before reaching Boxtel after 32 km. As in the most part of the Netherlands, there is hardly any elevation in this area, meaning that trains can drive at constant speeds. The elevation varies by 4 meters over a length of 32 km, which corresponds to gradients of 0.125 ‰[21] and therefore the impact on the driving performance can be neglected. Only the river bridges have steeper approaches that need to be covered.

[20] Compare Figure 1 in section 2

[21] ‰ equals one tenth of a percent, i.e. one per thousand.


*Figure 28: Elevation Profile of the Meteren - Boxtel Section*
*Source: Freemaptools Elevation Finder (2019)*

Today, the allowed maximum speed on the segment is 120 km/h. Except for some industrial railway sections and on port premises, the lines in the Netherlands are upgraded to maintain these speeds.

Exceptions are e.g. construction sites, track switches or curves, where reduced speed limits apply. These reductions are accounted for in the average speed calculations (compare Table 13). Freight trains manage to run at and maintain a velocity of 95 km/h due to their weight and resulting breaking capabilities. It is important to maintain this speed, as slower driving would decrease the line capacity and thus hinder the flow of other trains. Especially fast intercity trains enjoy a high priority in the Netherlands and, which is also the reason for the project's time focus of 23.00 to 07.00 o'clock, their operations are not to be interfered with. Also passing urban areas or train stations, railway operators are instructed by the infrastructure manager to drive at the speed of 95 km/h (Wittenberg, 2019)[22]. Thus, the base case uses a passing speed of maximum 95 km/h. The two policy alternatives are a reduction of the maximum speed to 40 km/h (alternative 1) and to 60 km/h (alternative 2) on the 32 km section between Meteren and Boxtel. Both variants are within the scope of this study, as the decision has not yet been made as to which alternative to pursue.

The study suggests that barging is a viable alternative to rail freight transportation. The major waterways in the pilot area, the Meuse and the Waal rivers, run in an East-West direction. However, both provide a good alternative. While the Waal river connects to the Rhine, which is the main North-South waterway arteria in central Europe, the Meuse continues southbound towards the cities of Maastricht close to the German border and to Liège in Belgium. From both cities, an onwoard transport by truck or rail is feasible.

[22] This assumption was verified with Mr. Wittenberg in a phone call on August 21, 2019.

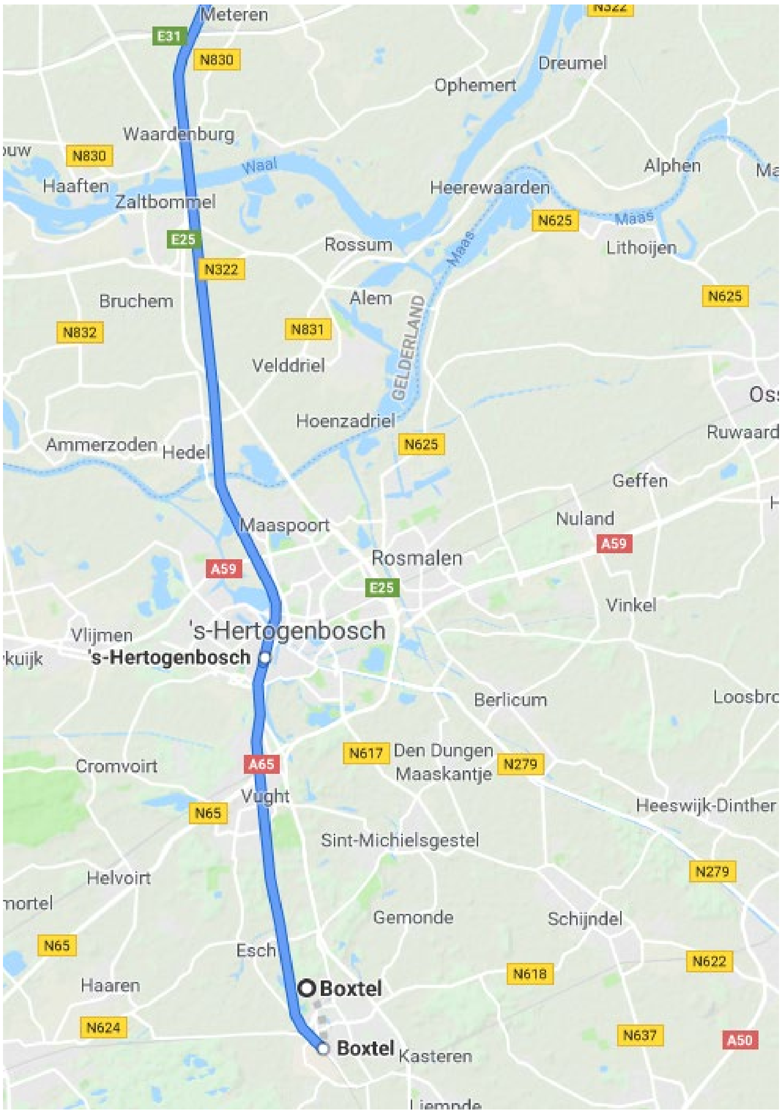


*Figure 29: The Segment Meteren – Boxtel*
*Source: Google Maps (2019)*

## 9.2. Objective of the Policy Alternatives

The overall aim of the project initiator, the Dutch Ministry of Infrastructure and Water Management, is to reduce the noise emissions caused by freight trains at night. This will have a direct positive impact on the health and quality of life of the population around the affected rail tracks. In order to justify a speed limit reduction for freight trains by night, the social costs and benefits have to be determined. Primarily, benefits are expected to stem from the noise reduction caused by slower trains passing at night, but also side effects must be investigated. These are, for example, lower freight train pollutant emissions, lower accident costs, less congestion or lower infrastructure maintenance costs.

However, the assumption is that freight train operators will have to bear higher costs caused by the measure, which potentially leads to a modal shift. This is in direct conflict with the current public debate about a need to fight pollutant emissions reinforcing the climate change. Rail is considered an eco-friendly mode with lower emission rates than trucking. Therefore, European and national governments and non-governmental institutions have stressed the importance of a well-working and highly utilized railway infrastructure to promote the mode's share in transport. Amongst others, legislation has been harmonized across Europe and policy packages introduced to promote competition and interoperability between countries.
Therefore, a positive effect with respect to the noise-affected target group must be weighed against the overall disadvantage of a less efficient transport system.

### 9.3. Demand Analysis and Modal Shift

The results found in the elasticity calculations from chapter 8.3.2 are now used to estimate the traffic volume shifting away from rail on this section. Furthermore, the section states basic assumptions necessary for the analysis, as for example average train weights or transport distances.
The basis of the modal shift estimation is the traffic forecast for the Meteren – Boxtel segment in 2040 provided by ProRail. Accordingly, 42 freight trains in total for both directions are projected to use this segment on average on a daily basis (ProRail B.V., 2017b). Likewise, the same source indicates a growth of railway freight transportation of 88% between 2014 and 2040, which equals a compound annual growth rate of 2.46%. As more detailed information are missing, this growth rate was used to discount the daily number of 42 trains to each year in the scope of the investigation, so that the following daily train numbers are assumed:

*Table 35: Daily Trains on the Meteren - Boxtel Section*

| year | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| daily trains | 33 | 34 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |

In order to estimate the tonne kilometre volumes, the numbers were converted as follows:

- The schedule analysis that was introduced in chapter 7.3 revealed the frequency distribution among the different train types and trip length clusters to be as follows.

*Table 36: Frequency Distribution of Freight Train Types*
*Rounded to one decimal*

| | **total** | long | medium | short |
|---|---|---|---|---|
| Wagonload Train | 18.7% | 4.2% | 3.4% | 11.0% |
| Block Train | 31.4% | 6.7% | 11.3% | 13.4% |
| Combined Transport | 49.9% | 20.6% | 5.9% | 23.4% |

- The schedule analysis revealed the average trip distance in km per train type on Dutch territory (for international connections, only the Dutch section was accounted for) to be as follows:

*Table 37: Average Distance per Train Type in km*
*Rounded to one decimal*

| | long | medium | short |
|---|---|---|---|
| Wagonload Train | 237.7 | 202.3 | 106.4 |
| Block Train | 197.7 | 198.0 | 140.5 |
| Combined Transport | 151.7 | 181.1 | 130.0 |

- From a separate analysis of data provided by ProRail, it is known that, on average, freight trains weigh approximately the same across the different types. This is due to the fact that heavy block trains, e.g. loaded with coal or ore, do not transport those goods back. Instead, they mostly ride back to their place of origin empty, i.e. the goods streams in these segments are imbalanced.[23] Opposed to that, containerized goods, which tend to be lighter, are transported in all directions, so that a higher productivity is achieved by avoiding empty runs. Accordingly, average gross weights of 1,238 tons for wagonload trains, 1,279 tons for block trains and 1,232 tons for combined transport container trains were found. For the analysis at hand, the following net loading weights are assumed:

[23] In an unrelated project conducted by Railistics, a manager “Coal Supply and Logistics” of the energy producer EnBW was interviewed. The person confirmed that coal trains run loaded from ARA-ports (Amsterdam, Rotterdam, Antwerp) to their power plants in the German state of Baden-Württemberg and the return trips to the seaport drive empty.

*Table 38: Net Loading Weights of Complete Train Sets per Train Type*
*Rounded to one decimal*

| | Wagonload Trains | Block Trains | Combined Transport |
|---|---|---|---|
| Average gross weight | 1,238 | 1,279 | 1,232 |
| | | | |
| Tare weight loco | 87 | 87 | 87 |
| Number of locos | 1 | 1,5 | 1 |
| | | | |
| tare weight wagon | 24 | 24 | 18,7 |
| Number of wagons | 25 | 25 | 30 |
| | | | |
| **net loading weight** | **551.2** | **548.0** | **583.9** |

This assumption seems realistic compared to other studies. Vierth, Sowa, and Cullinane (2019) conduct a CBA in the Swedish maritime context, using container trains with a gross weight of 1,300 tons carrying a payload of 650 tons. Compared to this payload, a net weight of 584 tons suggests a load factor of around 89,8%, which is also a realistic figure.

- In a project meeting, ProRail indicated that 28% of the freight train traffic in the Netherlands is driving through the night hours between 23:00 and 07:00 o'clock.

Multiplying the number of daily trains from Table 35 with the frequency distribution, the average distance, the net loading weights and the night traffic ratio produces the traffic quantities in tonne kilometres as a calculation basis. As an example, Table 39 shows the annual traffic volumes on Dutch territory in tkm of trains passing the Meteren – Boxtel segment in 2030.

*Table 39: Traffic Volume in tkm for the Year 2030, Rounded*

| | **total** | long | medium | short |
|---|---|---|---|---|
| Wagonload Train | 53,331,693 | 18,745,082 | 12,764,468 | 21,822,143 |
| Block Train | 100,632,160 | 24,563,585 | 41,331,389 | 34,737,186 |
| Combined Transport | 142,633,132 | 61,634,235 | 21,187,491 | 59,811,406 |
| | 296,596,984 | 104,942,901 | 75,283,347 | 116,370,736 |

In the following sub-sections, the modal shift for the two policy alternatives in tonne kilometres is calculated.

### 9.3.1. Alternative 1: Speed Limit Reduction to 40 km/h

For the first alternative, the cost increase per train type and distance segment was determined and presented in Table 24.

Plugging these values into the regression formulas for the respective segments yields the respective elasticities:

*Table 40: Elasticities for Alternative 1*

| | long | medium | short |
|---|---|---|---|
| Wagonload Train | 0.17 | 0.81 | 1.19 |
| Block Train | 0.33 | 0.37 | 1.28 |
| Combined Transport | 0.56 | 0.74 | 1.54 |

With the example of block trains on the medium distance, the modal shift is demonstrated:

The traffic volume for this segment was calculated to be 41,331,389 tkm in 2030.

The modal shift is obtained by multiplying this volume by the cost increase of 2.0% and the corresponding elasticity of 0.37[24], i.e.

$$41{,}331{,}389 \text{ tkm} \quad \text{x} \quad 2.0\% \quad \text{x} \quad 0.37 \quad = \quad 310{,}195 \text{ tkm} \qquad (2)$$

For the remaining segments, the following modal shift was calculated.

*Table 41: Modal Shift in tkm for Alternative 1 in 2030*

| | long | medium | short |
|---|---|---|---|
| Wagonload Train | 11,182 | 163,999 | 731,368 |
| Block Train | 58,570 | 310,195 | 1,890,350 |
| Combined Transport | 300,010 | 285,442 | 4,598,487 |

The assumptions as to where declining rail freight volumes will shift to was portrayed in section 8.3.1 and, thus, the following allocation key applies to the modal shift in 2030:

*Table 42: Allocation of Shifting Volumes to other Modes*

| | Barge | Truck |
|---|---|---|
| Wagonload Trains | 0% | 50% |
| Block Trains | 0% | 0% |
| Combined Transport | 0% | 27.0% |

[24] Rounding deviations may occur

Where the numbers do not add up to 100%, the shift will not happen, but the transport volumes will remain with rail.

As a final result, the speed limit reduction on the Meteren – Boxtel section will lead to the following modal shift in 2030, measured in tonne kilometres:

To inland waterway transport:

*Table 43: Modal Shift to Barge for Alternative 1 in 2030, in tkm*

| | long | medium | short | total |
|---|---|---|---|---|
| Wagonload Train | - | - | - | - |
| Block Train | - | - | - | - |
| Combined Transport | - | - | - | - |

To road transport:

*Table 44: Modal Shift to Truck for Alternative 1 in 2030, in tkm*

| | long | medium | short | total |
|---|---|---|---|---|
| Wagonload Train | 5,591 | 81,999 | 365,684 | 453,274 |
| Block Train | - | - | - | - |
| Combined Transport | 81,003 | 77,069 | 1,241,591 | 1,399,663 |

### 9.3.2. Alternative 2: Speed Limit Reduction to 60 km/h

The identic procedure as in the previous sub-section leads to the results for alternative 2. The cost increase per train type and distance segment was determined and presented in Table 25 Cost Increase for Alternative 2 (60km/h).

Plugging these values into the regression formulas for the respective segments yields the respective elasticities:

*Table 45: Elasticities for Alternative 2*

| | long | medium | short |
|---|---|---|---|
| Wagonload Train | 0.17 | 0.79 | 1.15 |
| Block Train | 0.32 | 0.33 | 1.15 |
| Combined Transport | 0.54 | 0.68 | 1.40 |

With the example of block trains on the medium distance, the modal shift is demonstrated:

The traffic volume for this segment was calculated to be 41,331,389 tkm in 2030.

The modal shift is obtained by multiplying this volume by the cost increase of 0.86% and the corresponding elasticity of 0.33[25], i.e.

$$41{,}331{,}389 \text{ tkm} \quad x \quad 0.86\% \quad x \quad 0.33 \quad = \quad 118{,}171 \text{ tkm} \tag{2}$$

For the remaining segments, the following modal shift was calculated.

*Table 46: Modal Shift from Rail to other Modes for Alternative 2 in 2030, in tkm*

| | long | medium | short |
|---|---|---|---|
| Wagonload Train | 12,396 | 94,150 | 358,994 |
| Block Train | 22,645 | 118,171 | 697,863 |
| Combined Transport | 120,813 | 110,036 | 1,751,079 |

Again, the same allocation key applies to the modal shift in 2030.

As a final result, the speed limit reduction on the Meteren – Boxtel section will lead to the following modal shift, measured in tonne kilometres:

To inland waterway transport:

*Table 47: Modal Shift to Barge for alternative 2 in 2030, in tkm*

| | long | medium | short | total |
|---|---|---|---|---|
| Wagonload Train | - | - | - | - |
| Block Train | - | - | - | - |
| Combined Transport | - | - | - | - |

To road transport:

*Table 48: Modal Shift to Truck for alternative 2 in 2030, in tkm*

| | long | medium | short | total |
|---|---|---|---|---|
| Wagonload Train | 6,198 | 47,075 | 179,497 | 232,770 |
| Block Train | - | - | - | - |
| Combined Transport | 32,620 | 29,710 | 472,791 | 535,121 |

[25] Rounding deviations may occur

In total, the following modal shift per year in tonne-kilometres was found:

*Table 49: Modal Shift for Both Alternatives, 2030-2040*

| | A1 (40 km/h) | | | A2 (60 km/h) | | |
|---|---|---|---|---|---|---|
| | to barge | to truck | remaining rail | to barge | to truck | remaining rail |
| **2030** | - | 1,852,938 | 294,744,046 | - | 767,890 | 295,829,094 |
| **2031** | 2,392,223 | 3,818,175 | 299,374,373 | 901,703 | 1,582,319 | 303,100,749 |
| **2032** | 4,783,218 | 3,819,403 | 296,982,150 | 1,802,937 | 1,582,788 | 302,199,046 |
| **2033** | 4,923,901 | 3,931,738 | 305,716,919 | 1,855,964 | 1,629,341 | 311,087,253 |
| **2034** | 5,064,584 | 4,044,073 | 314,451,689 | 1,908,992 | 1,675,894 | 319,975,461 |
| **2035** | 5,205,267 | 4,156,409 | 323,186,458 | 1,962,019 | 1,722,446 | 328,863,668 |
| **2036** | 5,345,950 | 4,268,744 | 331,921,227 | 2,015,047 | 1,768,999 | 337,751,875 |
| **2037** | 5,486,633 | 4,381,080 | 340,655,996 | 2,068,074 | 1,815,551 | 346,640,082 |
| **2038** | 5,627,316 | 4,493,415 | 349,390,765 | 2,121,102 | 1,862,104 | 355,528,290 |
| **2039** | 5,767,998 | 4,605,750 | 358,125,534 | 2,174,129 | 1,908,657 | 364,416,497 |
| **2040** | 5,908,681 | 4,718,086 | 366,860,303 | 2,227,157 | 1,955,209 | 373,304,704 |

## 9.4. Project Costs

Traditionally, cost-benefit analyses serve the purpose of comparing the recurring costs and benefits of a project to typically large one-off investment costs. In the case of this specific analysis, no such costs are relevant, as the decision to be made concerns a policy change rather than a large financial investment. Therefore, this study assumes no initial investment cost, such as design or consulting fees or any policy document change cost.

## 9.5. Economic Analysis

In the scope of this analysis, eight different cost elements were investigated. Two of these, infrastructure maintenance and operating costs (i.e. the user costs for road, rail and waterway transport) are also financial costs, while the six remaining elements represent external effects. These are noise, air pollution, climate change costs, accidents, transport time and congestion.
As opposed to the financial analysis, certain cost components must not be taken into account. This applies, for example, to interest payments, depreciation or social security contributions, as these are value transfers from the private to the public sector and therefore do not affect available resources. In the case of wages, for example, the Dutch income tax rate of 38.10% applying to the income bracket of 34,300 € to 68,507 € is deducted.

Furthermore, for certain elements shadow prices must be applied. This is the case when market-based transaction values do not accurately reflect the true value (i.e. the opportunity costs) to society, which is the ulterior motive in a CBA. In this case, conversion factors can be applied to transform the observed values into opportunity values. The EC (2008, p.150) provides such conversion factors as outlined in Table 50.

*Table 50: Conversion Factors for Shadow Prices in CBA*

| Type of Cost | Conversion Factor |
|---|---|
| Labour | 0.747 |
| Raw Materials | 1.000 |
| Carriage | 0.777 |
| Works | 0.867 |
| Equipment | 0.918 |
| Maintenance | 0.835 |

These conversion factors apply to financial costs, e.g. maintenance and operating expenditures, but not to social costs like pollutant emissions or accident costs.

In the following sub-chapters, the single cost rates and their respective sources are explained. Table 51 summarizes these cost rates for a better comparison.

*Table 51: Economic Cost Rates Applied in the CBA*

| **Direct Costs** | **Unit** | **Rail** | **Road** | **Waterway** |
|---|---|---|---|---|
| Infrastructure Maintenance | 1,000 vkm | 1.499,44 € | 104,00 € | 540,00 € |
| | | | | |
| Operating Costs | | | | |
| Holding costs | 1,000 vkm | 1.867,73 € | 169,66 € | 22.668,43 € |
| Fuel/energy | 1,000 vkm | 505,89 € | 229,50 € | 1.915,00 € |
| Crew | per hour | 25,85 € | 13,71 € | 207,32 € |
| | | | | |
| Travel time | | | | |
| Containerized goods | 1,000 tkm | - | 3,34 € | 52,59 € |
| Other goods | 1,000 tkm | - | 2,18 € | 34,33 € |
| | | | | |
| Accidents | 1,000 tkm | 232,27 € | 19.743,21 € | 2.589,70 € |
| | | | | |
| **Indirect Costs** | | **Rail** | **Road** | **Waterway** |
| Noise | 1,000 vkm | 977,99 € | 105,15 € | - € |
| Air pollution | 1,000 vkm | 476,95 € | 47,14 € | 9.154,64 € |
| Climate Change | 1,000 vkm | 1.029,48 € | 77,32 € | 4.130,14 € |
| Congestion | 1,000 tkm | 0,56 € | 16,10 € | - € |

The values in the table above have been converted to be of the equal unit. However, the original approach to find the cost rates may have been different, as in the case of infrastructure maintenance costs. For rail, these were calculated in Euros per tonne-kilometre, while for road and waterway transport rates in Euros per vehicle-kilometre were found. For better comparability, these values were harmonized using appropriate conversions. Further assumptions used in the scope of the analysis and that have not been mentioned before are listed in the following table.

*Table 52: General CBA Assumptions*

| Categoriy | Value |
|---|---|
| Average truck speed | 62 km/h |
| Average train speed | 53 km/h |
| Average barge speed | 16.7 km/h |
| | |
| Average barge load | 1,541 tons |
| Average combined transport load | 584 tons |
| Average block train load | 548 tons |
| Average barge load | 551 tons |
| Average truck load | 13 tons |
| | |
| Truck driver wage, net of tax | 13.71 € |
| Barge annual crew cost, net of tax | 186,324 € |
| Income tax rate NL | 38.10% |
| | |
| Truck holding costs per 100 km | 27.11 € |
| Barge (general cargo) holding costs p.a. | 255,275 € |
| Barge (tanker) holding costs p.a. | 319,302 € |
| | |
| Net fuel price (Diesel per litre) | 0.853 € |
| Truck diesel consumption per 100 km | 26.9 L |
| | |
| Compund annual inflation rate NL | 1.369% |
| Noise affected poulation urban | 70.30% |
| Noise affected poulation outside agglomerations | 29.70% |
| Share of freight trains at night | 28% |
| Compound annual growth of freight rail demand | 2.458% |

### 9.5.1. Infrastructure Maintenance

In the Netherlands, the total rail network has a length of 7,146 km and ProRail spent some 718€m on its total maintenance programme in 2017, including large-scale maintenance, small-scale maintenance, maintenance of station, management and planning efforts as well as research & development (ProRail B.V., 2018b). The variable proportion of these costs is not indicated, thus the small-scale maintenance costs of 303€m is used to approximate the wear and tear caused by trains, while for example large-scale maintenance is rather of strategic nature.

On the network, trains drove 54 billion tonne kilometres which equals to track maintenance costs of 0.0056€$_{2019}$ per tkm. The weight-distance-based perspective is chosen rather than the pure distance-based (i.e. train kilometre) perspective in order to account for the higher damage potential of freight trains due to their higher weights. As some 24.1% of the tonne kilometres on the Dutch Network are driven by freight trains, 0.0014€$_{2019}$ per tonne kilometre are allocated to freight trains. Applying a conversion factor of 0.835 yields a final rate of 0.0012€$_{2019}$ per tonne kilometre. If only train kilometres were considered, maintenance costs of 2.825€ per train kilometre would accrue (ProRail B.V., 2018b). It is acknowledged that the speed reduction does have an effect on infrastructure cost related to the remaining traffic. However, these are expected to be negligible (consider, for instance, that the train uses the tracks longer at lower speeds) and are therefore excluded in this study.

Concerning road maintenance, CE Delft distinguishes between fixed and variable maintenance costs for trucks heavier than 12 tons and truck-trailer combinations on urban roads, inter-urban roads and motorways. The averaged variable portion of these is used as marginal infrastructure maintenance costs per vehicle kilometre amounting to 0.125€$_{2019}$ per truck kilometre and 0.104€$_{2019}$ including the conversion factor of 0.835.

Likewise, the marginal infrastructure costs for inland cargo ships are based on the variable infrastructure costs that adapt to the traffic volume, as presented in a study specifically for the Netherlands by the European Commission (2005). These include traffic control, policing and operations of locks and bridges. All of these elements are divided into a fixed and a variable component and an allocation ratio for cargo ships opposed to passenger ships. Finally, they arrive at average marginal infrastructure cost of 0.65€$_{2019}$ per freight vessel kilometre. Multiplying with the conversion factor of 0.835, the final value of 0.54€$_{2019}$ per freight vessel kilometre is obtained.

Costs with respect to infrastructure maintenance arise form additional use of roads and waterways, while the reduced train kilometres and the resulting cost reduction will be presented in the benefits section.

From the chapter on modal shift, the number of tonne kilometres shifting to other modes is known. The average net truckload in the Netherlands is around 13 tons (Eurostat, 2019b) and dividing the shifting tonne kilometres by this average weight yields the estimated addition vehicle kilometres on

Dutch roads. This is multiplied by marginal infrastructure maintenance costs of 0.125€ per vkm as described above.

The same method was applied to barges with the marginal cost rate of 0.65€ per vessel kilometre. The vessel kilometres were determined by dividing the shifted tonne kilometres by the average net vessel load of 1,541 tons, which was calculated based on the number of ship movements and the total transported volume from Destatis (2019)[26].

*Table 53: Infrastructure Maintenance Costs for Alternative 1, 40km/h, undiscounted*

| | Rail | Road | Inland Shipping | Total |
|---|---|---|---|---|
| 2030 | -2,148 € | 14,829 € | 0 € | **12,681 €** |
| 2031 | -7,198 € | 30,556 € | 842 € | **24,200 €** |
| 2032 | -9,971 € | 30,566 € | 1,685 € | **22,280 €** |
| 2033 | -10,264 € | 31,465 € | 1,734 € | **22,935 €** |
| 2034 | -10,557 € | 32,364 € | 1,784 € | **23,591 €** |
| 2035 | -10,851 € | 33,263 € | 1,833 € | **24,245 €** |
| 2036 | -11,144 € | 34,162 € | 1,883 € | **24,901 €** |
| 2037 | -11,437 € | 35,061 € | 1,932 € | **25,556 €** |
| 2038 | -11,730 € | 35,960 € | 1,982 € | **26,212 €** |
| 2039 | -12,024 € | 36,859 € | 2,031 € | **26,866 €** |
| 2040 | -12,317 € | 37,758 € | 2,081 € | **27,522 €** |

*Table 54: Infrastructure Maintenance Costs for Alternative 2, 60km/h, undiscounted*

| | Rail | Road | Inland Shipping | Total |
|---|---|---|---|---|
| 2030 | -890 € | 6,145 € | 0 € | **5,255 €** |
| 2031 | -2,879 € | 12,663 € | 318 € | **10,101 €** |
| 2032 | -3,924 € | 12,667 € | 635 € | **9,377 €** |
| 2033 | -4,040 € | 13,039 € | 654 € | **9,653 €** |
| 2034 | -4,155 € | 13,412 € | 672 € | **9,929 €** |
| 2035 | -4,270 € | 13,784 € | 691 € | **10,205 €** |
| 2036 | -4,386 € | 14,157 € | 710 € | **10,481 €** |
| 2037 | -4,501 € | 14,529 € | 728 € | **10,757 €** |
| 2038 | -4,617 € | 14,902 € | 747 € | **11,032 €** |
| 2039 | -4,732 € | 15,275 € | 766 € | **11,308 €** |
| 2040 | -2,266 € | 15,647 € | 0 € | **13,381 €** |

### 9.5.2. Operating costs

Although operating costs for freight trains increase as explained in detail in chapters 7.3, the decrease of traffic volumes still generates benefits. The benefits are the difference between the increasing operating costs for the remaining traffic and the eliminated costs from the discontinued traffic. For

[26] The national German database provides information on international river goods transport on the Rhine

the former, the difference in costs per train kilometre before and after the introduction of the speed limit was multiplied with the remaining driven train kilometres to find the total difference in operating cost born by the operators. The latter is obtained by multiplying the original costs per train kilometre with the eliminated traffic volume.

It must be noted that in the calculation of economic costs and benefits, other cost rates have been used compared to the financial analysis in chapter 7.3. This is due to the distortion of market prices (e.g. caused by the shortage of train drivers) and tax payments (e.g. on fuel or income). The conversion factors mentioned at the beginning of the chapter and the income tax deduction of 38.10% are included in the economic analysis.

Regarding road transport, vehicle holding costs including maintenance, crew costs and fuel are considered. Depreciation of the assets and interest payments are excluded, as these are financial elements used for accounting purposes. For trucks and barges, the information are taken and adapted to current price levels from the BVWP (2015) cost handbook, also applying a conversion factor to account for price distortions, e.g. caused by imperfect markets. They include repair of wear and tear (e.g. tyres), costs for lubricants, insurance and maintenance under assumed productive operating times per annum.

With respect to trucks, three different models from different weight classes[27] were averaged for a final holding cost of 27.11€ per 100 km. On top, wage costs of 13.71€ per hour net of tax were added. The operating hours were assumed to be the total tonne kilometres known from the modal shift, divided by 13 tons average net load (compare previous section) and divided by an average speed for freight vehicles of 62 km/h in the Netherlands (Ligterink, 2016).

The fuel consumption varies significantly under different operating conditions, such as traffic flow, speed or road geometry. For the three vehicle types mentioned before, the same source provides consumption tables for different speeds and traffic conditions. An average of 26.9 litres per 100 km are thus assumed. The average price for diesel at Dutch gas stations in 2018 was 1.335€ per litre. Deducting the Dutch fuel tax[28] yields a net fuel price of 0.853€ per litre.

For barges, a similar approach and was used, however with a differentiation of ship types between container vessels (assumed to carry the diverted traffic volume from combined transport) and bulk

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[27] Mercedes Atego 818L (3.5-12t), MAN TGX 18.440 XLX (12-22t), Mercedes Actros 2544 LL (>22t)

[28] Opposed to financial analyses, taxes are excluded from the economic CBA as they merely represent transfer payments from private entities to the public

vessels (assumed to carry the diverted traffic volume from block and wagonload trains). Based on their respective capacities and trips per annum[29], the additional number of vessels could be estimated. These were combined with the specific holding costs, the average values for crew occupation, wages and fuel consumption obtained from BVWP (2015). Again, wages were corrected for income tax deducting a rate of 38.10%.

In the first year, the modal shift is not yet big enough to compensate the higher operating costs for rail. The shift outweighs the higher costs per kilometre only from year 2031 onwards, resulting in a benefit.

*Table 55: Operating Cost Changes for Alternative 1, undiscounted*

| | Rail | Road | Inland Shipping | Total |
|---|---|---|---|---|
| 2030 | 45,729 € | 80,443 € | 0 € | **126,172 €** |
| 2031 | -52,234 € | 165,761 € | 79,828 € | **193,355 €** |
| 2032 | -104,972 € | 165,814 € | 160,581 € | **221,423 €** |
| 2033 | -108,060 € | 170,691 € | 165,363 € | **227,994 €** |
| 2034 | -111,147 € | 175,568 € | 170,148 € | **234,569 €** |
| 2035 | -114,234 € | 180,445 € | 174,937 € | **241,148 €** |
| 2036 | -117,322 € | 185,322 € | 179,729 € | **247,729 €** |
| 2037 | -120,409 € | 190,199 € | 184,525 € | **254,315 €** |
| 2038 | -123,497 € | 195,076 € | 189,324 € | **260,903 €** |
| 2039 | -126,584 € | 199,953 € | 194,126 € | **267,495 €** |
| 2040 | -129,672 € | 204,829 € | 199,092 € | **274,249 €** |

*Table 56: Operating Cost Changes for Alternative 2, undiscounted*

| | Rail | Road | Inland Shipping | Total |
|---|---|---|---|---|
| 2030 | -35,916 € | 33,337 € | 0 € | **-2,579 €** |
| 2031 | -37,382 € | 68,694 € | 30,078 € | **61,390 €** |
| 2032 | -37,576 € | 68,715 € | 60,276 € | **91,415 €** |
| 2033 | -38,681 € | 70,736 € | 62,057 € | **94,112 €** |
| 2034 | -39,786 € | 72,757 € | 63,839 € | **96,810 €** |
| 2035 | -40,891 € | 74,778 € | 65,621 € | **99,508 €** |
| 2036 | -41,996 € | 76,799 € | 67,404 € | **102,207 €** |
| 2037 | -43,101 € | 78,820 € | 69,187 € | **104,906 €** |
| 2038 | -44,207 € | 80,841 € | 70,971 € | **107,605 €** |
| 2039 | -45,312 € | 82,862 € | 72,755 € | **110,305 €** |
| 2040 | -46,417 € | 84,883 € | 74,562 € | **113,028 €** |

### 9.5.3. Externalities

With respect to externalities, noise, air pollution, climate change effects, accident costs, transport time and congestion concern society as a whole and not only those who cause these costs. The

[29] Sources: Statistics Netherlands (CBS, 2019), BVB (2017)

reduction of rail freight-related externalities, i.e. costs to non-users, is the main source of benefits associated with the policy plan to reduce speed for freight trains. These benefits are denoted as negative costs.

#### 9.5.3.1. Noise

Noise pollution is the original driver of the project, as the population situated adjacent to railway lines is disturbed by its sound emissions. The methods to quantify noise have been described in section 4.2.4, where it was outlined that it is differentiated between hedonic and contingent valuation methods. Both require extensive data collection. For the hedonic method, substantial research of the housing market would be necessary, including number of buildings, different properties, their respective values and the noise conditions they are subject to. The contingent method requires information about the number of people and their exposure to different noise levels. If both were to be directly measured, the scope and budget of the study would not be sufficient. Only the government-led trial run in late 2019 will provide the required conditions for noise measurements. Therefore, secondary data from previous research are used to approximate the noise benefits from a speed reduction based on the contingent method.

The benefits from railway noise reductions come from two sources. Firstly, the traffic reduction in train kilometres and secondly the lower emissions caused by the remaining trains driving more slowly at night.

The reduction in train kilometres is valued at marginal noise costs peer 1,000 train-kilometres of 2,977.07€ inside agglomerations and 132.47€ outside of agglomerations (RICARDO-AEA, 2014, updated to 2019 price levels). As no area-specific socio-geographic distribution is available, it was assumed that 70.3% of the affected persons live inside of agglomerations and 29.7% in rural areas. This ratio is based on the number of inhabitants in the Netherlands affected by railway noise presented by the EEA and was gathered under the European Noise Directive 2002/49/EC in 2018 (EEA, 2018). This results in a weighted rate of 977.98€ per 1,000 vkm.

As no measurements into the real sound levels have been carried out, valuating the effect of the speed reduction is much more difficult. In order to find an acceptable value, the costs for the remaining trains travelling on the Meteren – Boxtel segment were valued at the same marginal costs as explained before. Then, the theoretical reduction in dB(A) was estimated based on the mathematical freight train noise modelling of Windelberg (2008). Accordingly, the influence of speed on noise emissions is characterized by the formula

$$D_v = 20 * \log_{10} [0.01 * v] \quad (3)$$

with

$D_v$ = the influence of the speed level on the dB(A) emissions and

v = the speed of the freight train.

Plugging in the different speeds yields the following values:

*Table 57: Sound Level Differences at Different Speeds*

| v in km/h | $D_v$ | $\Delta D_v$ |
|---|---|---|
| 95 | -0.45 | |
| 60 | -4.44 | -3.99 |
| 40 | -7.96 | -7.51 |

The difference between the noise emissions at a speed of 95km/h and 40km/h is thus 7.5 dB(A) and 4 dB(A) for 60km/h respectively. Due to the logarithmic nature of sound perception, the perceived noise burden is halved by a reduction in 10 dB(A), i.e. reduced by 50% (EEA, 2014). Thus, the marginal noise costs for the Meteren – Boxtel segment were reduced by 0.75 * 0.5 in alternative 1 and 0.4 * 0.5 in alternative 2.

For both alternatives, undiscounted benefits accrue as indicated in the table below:

*Table 58: Noise Reduction Benefits due to Reduced Rail Traffic, undiscounted*

| | Alternative 1: 40km/h | | | Alternative 2: 60km/h | | |
|---|---|---|---|---|---|---|
| | **traffic loss** | **speed reduction** | **total** | **traffic loss** | **speed reduction** | **total** |
| **2030** | -6,862 € | -77,682 € | -84,544 € | -2,854 € | -41,417 € | -44,271 € |
| **2031** | -23,151 € | -78,912 € | -102,063 € | -9,275 € | -42,437 € | -51,712 € |
| **2032** | -32,162 € | -78,282 € | -110,444 € | -12,670 € | -42,311 € | -54,981 € |
| **2033** | -33,108 € | -80,584 € | -113,693 € | -13,043 € | -43,556 € | -56,598 € |
| **2034** | -34,054 € | -82,887 € | -116,941 € | -13,415 € | -44,800 € | -58,215 € |
| **2035** | -35,000 € | -85,189 € | -120,189 € | -13,788 € | -46,045 € | -59,832 € |
| **2036** | -35,946 € | -87,492 € | -123,438 € | -14,160 € | -47,289 € | -61,450 € |
| **2037** | -36,892 € | -89,794 € | -126,686 € | -14,533 € | -48,534 € | -63,067 € |
| **2038** | -37,838 € | -92,097 € | -129,934 € | -14,906 € | -49,778 € | -64,684 € |
| **2039** | -38,784 € | -94,399 € | -133,183 € | -15,278 € | -51,022 € | -66,301 € |
| **2040** | -39,730 € | -96,701 € | -136,431 € | -15,651 € | -52,267 € | -67,918 € |

However, if traffic shifts away from rail towards other modes, this potentially creates disturbance elsewhere. The new traffic borne by trucks causes additional noise. The European Commission's Handbook on External Costs of Transport (RICARDO-AEA, 2014) suggests different marginal noise costs for heavy goods vehicle in different conditions, such as the time of day, the traffic density or the population structure. As no estimation can be made as to when and where exactly the diverted transports will take place, the average value of 105.15€$_{2019}$ per 1,000 vkm is applied.

Inland waterway shipping does create noise, as operating a combustion engine and other operational processes imply. However, in accordance with the EU CBA guidelines and other studies, inland waterway shipping does not bear any noise costs (EC, 2014; Díaz, 2011; Ricardo-AEA, 2014; Vierth *et al.*, 2019)

Table 59 shows the additional costs caused by the additional road traffic under alternative 1, i.e. a reduction of the speed limit to 40 km/h, in direct comparison with the saving generated by slower driving trains. Table 60 shows the same for alternative 2, a reduction of the speed limit to 60 km/h. In both cases, the negative totals imply a final benefit, which confirms the policy implementation in its aim to reduce noise-related disturbance.

*Table 59: Total Noise Costs for Alternative 1, 40km/h, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -84,544 € | 14,987 € | - | **-69,557 €** |
| 2031 | -102,063 € | 30,883 € | - | **-71,180 €** |
| 2032 | -110,444 € | 30,893 € | - | **-79,551 €** |
| 2033 | -113,693 € | 31,802 € | - | **-81,891 €** |
| 2034 | -116,941 € | 32,710 € | - | **-84,231 €** |
| 2035 | -120,189 € | 33,619 € | - | **-86,570 €** |
| 2036 | -123,438 € | 34,528 € | - | **-88,910 €** |
| 2037 | -126,686 € | 35,436 € | - | **-91,250 €** |
| 2038 | -129,934 € | 36,345 € | - | **-93,589 €** |
| 2039 | -133,183 € | 37,254 € | - | **-95,929 €** |
| 2040 | -136,431 € | 38,162 € | - | **-98,269 €** |

*Table 60: Total Noise Costs for Alternative 2, 60km/h, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -44,271 € | 6,211 € | - | **-38,060 €** |
| 2031 | -51,712 € | 12,799 € | - | **-38,913 €** |
| 2032 | -54,981 € | 12,802 € | - | **-42,179 €** |
| 2033 | -56,598 € | 13,179 € | - | **-43,419 €** |
| 2034 | -58,215 € | 13,555 € | - | **-44,660 €** |
| 2035 | -59,832 € | 13,932 € | - | **-45,900 €** |
| 2036 | -61,450 € | 14,309 € | - | **-47,141 €** |
| 2037 | -63,067 € | 14,685 € | - | **-48,382 €** |
| 2038 | -64,684 € | 15,062 € | - | **-49,622 €** |
| 2039 | -66,301 € | 15,438 € | - | **-50,863 €** |
| 2040 | -67,918 € | 15,815 € | - | **-52,103 €** |

#### 9.5.3.2. Air pollution

Air pollution is a major component of most cost-benefit analyses and the marginal air pollution costs provided by the EC (Ricardo-AEA, 2014) contain the damaging pollutants $NH_3$, VOC, $NO_x$, particular matter, and $SO_2$.

The study values marginal air pollution costs from electric freight trains at 0.47€$_{2019}$ per train kilometre. As with climate change costs, the production of energy accounts for most of the emission of the pollutants $NH_3$, VOC, $NO_x$, particular matter, and $SO_2$. Furthermore, the reduced energy demand related to the slower speed on the 32 km section was calculated. Based on Ricardo-AEA (2014), this energy consumption difference was transformed into reduced emissions and costs per emitted unit of pollutants. Concerning the other modes, 0.047€$_{2019}$ per truck kilometre are suggested and 9.15€$_{2019}$ for vessels respectively. The reduction of rail freight volumes generates a benefit. However, the shift to road and waterway transport creates social costs larger than the benefits.

*Table 61: Air Pollution Costs for Alternative 1, undiscounted*

| | Rail[30] | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -12,226 € | 6,720 € | 0 € | **-5,506 €** |
| 2031 | -14,078 € | 13,847 € | 14,212 € | **13,981 €** |
| 2032 | -14,895 € | 13,851 € | 28,416 € | **27,372 €** |
| 2033 | -15,333 € | 14,258 € | 29,252 € | **28,177 €** |
| 2034 | -15,771 € | 14,666 € | 30,088 € | **28,983 €** |
| 2035 | -16,209 € | 15,073 € | 30,923 € | **29,787 €** |
| 2036 | -16,647 € | 15,481 € | 31,759 € | **30,593 €** |
| 2037 | -17,085 € | 15,888 € | 32,595 € | **31,398 €** |
| 2038 | -17,523 € | 16,295 € | 33,431 € | **32,203 €** |
| 2039 | -17,961 € | 16,703 € | 34,266 € | **33,008 €** |
| 2040 | -18,399 € | 17,110 € | 35,102 € | **33,813 €** |

*Table 62: Air Pollution Costs for Alternative 2, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -8,547 € | 2,785 € | 0 € | **-5,762 €** |
| 2031 | -9,408 € | 5,738 € | 5,357 € | **1,687 €** |
| 2032 | -9,726 € | 5,740 € | 10,711 € | **6,725 €** |
| 2033 | -10,012 € | 5,909 € | 11,026 € | **6,923 €** |
| 2034 | -10,298 € | 6,078 € | 11,341 € | **7,121 €** |
| 2035 | -10,584 € | 6,246 € | 11,656 € | **7,318 €** |
| 2036 | -10,870 € | 6,415 € | 11,971 € | **7,516 €** |
| 2037 | -11,156 € | 6,584 € | 12,286 € | **7,714 €** |
| 2038 | -11,442 € | 6,753 € | 12,601 € | **7,912 €** |
| 2039 | -11,728 € | 6,922 € | 12,916 € | **8,110 €** |

[30] Note that the rail-related pollution savings not only include the avoided train rides, but also the savings related to slower speed. Therefore the amount attributed to rail transport is larger despite the lower per-ton emissions compared to trucking.

| | | | | |
|---|---|---|---|---|
| 2040 | -12,014 € | 7,091 € | 13,231 € | **8,308 €** |

#### 9.5.3.3. Climate change

Frequently, climate change costs are presented separately from air pollution emissions in CBAs, thus this study adapts this practice. For modes powered by fossil fuels, the $CO_2$ emissions result from the combustion process in the engine and are quantified on a per vehicle-kilometre basis or a per tonne-kilometre basis. Concerning electrically powered trains, $CO_2$ emissions are a product of the up-stream production of energy and depend on the amount of energy consumed, measured in kWh.

The climate change benefits are associated with trains driving at lower speeds and the cancelled rail transport volume, i.e. the benefits are climate change cost savings. The former is the considerably bigger source of benefits. For the different production systems, the kWh saved by driving slower on the 32-km segment and by the avoided trips have been multiplied by the cost rate of 0.066€$_{2019}$ per kWh (RICARDO-AEA, 2014).

For additional road traffic, marginal $CO_2$-emission costs of 0.077€$_{2019}$ per vkm (RICARDO-AEA, 2014) accrue, while a rate of 2.68€$_{2019}$ per tonne-kilometre is indicated for the additional volumes on inland waterways.

*Table 63: Climate Change Costs for Alternative 1, undiscounted*

| | Rail[31] | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -39,260 € | 11,021 € | 0 € | **-28,238 €** |
| 2031 | -43,198 € | 22,711 € | 6,412 € | **-14,076 €** |
| 2032 | -44,841 € | 22,718 € | 12,820 € | **-9,303 €** |
| 2033 | -46,159 € | 23,386 € | 13,197 € | **-9,576 €** |
| 2034 | -47,478 € | 24,054 € | 13,574 € | **-9,850 €** |
| 2035 | -48,797 € | 24,723 € | 13,951 € | **-10,123 €** |
| 2036 | -50,116 € | 25,391 € | 14,328 € | **-10,397 €** |
| 2037 | -51,435 € | 26,059 € | 14,705 € | **-10,671 €** |
| 2038 | -52,754 € | 26,727 € | 15,082 € | **-10,944 €** |
| 2039 | -54,072 € | 27,395 € | 15,459 € | **-11,218 €** |
| 2040 | -55,391 € | 28,063 € | 15,836 € | **-11,491 €** |

[31] Note that the rail-related $CO_2$ savings not only include the avoided train rides, but also the savings related to slower speed. Therefore the amount attributed to rail transport is larger despite the lower per-ton emissions compared to trucking.

*Table 64: Climate Change Costs for Alternative 2, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -38,630 € | 4,567 € | 0 € | **-34,063 €** |
| 2031 | -40,876 € | 9,412 € | 2,417 € | **-29,048 €** |
| 2032 | -41,494 € | 9,415 € | 4,832 € | **-27,247 €** |
| 2033 | -42,714 € | 9,691 € | 4,974 € | **-28,049 €** |
| 2034 | -43,935 € | 9,968 € | 5,116 € | **-28,850 €** |
| 2035 | -45,155 € | 10,245 € | 5,259 € | **-29,651 €** |
| 2036 | -46,376 € | 10,522 € | 5,401 € | **-30,453 €** |
| 2037 | -47,596 € | 10,799 € | 5,543 € | **-31,254 €** |
| 2038 | -48,816 € | 11,076 € | 5,685 € | **-32,056 €** |
| 2039 | -50,037 € | 11,353 € | 5,827 € | **-32,857 €** |
| 2040 | -51,257 € | 11,630 € | 5,969 € | **-33,658 €** |

#### 9.5.3.4. Accidents

Estimating the accident costs per mode includes information on costs for medical treatment, damaged property, loss of productivity, also measured in the value of a statistical live, and the emotional component, which is the willingness to pay for avoiding the accident and the resulting grieving and suffering (RICARDO-AEA, 2014).

Although the average costs per incident are higher, marginal accident costs for railways are lower than for road transport, as the probability of an accident and the number of trips are significantly smaller. In the scope of this study, a marginal cost rate of 0.23€$_{2019}$ per tonne kilometre applies. Similar to the train-related infrastructure costs, the impact of slower driving of freight trains on the probability and costs of accidents could not be determined. It is excluded in this study.

An amount of 19.74€$_{2019}$ per 1,000 tkm is appropriate to cover the risk of accidents caused by heavy goods vehicles. For barges, the risk of causing accidents is significantly smaller and is thus valuated at 0.00259€$_{2019}$ per tkm.

*Table 65: Accident Costs for Alternative 1, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -430 € | 36,583 € | 0 € | **36,153 €** |
| 2031 | -1,443 € | 75,383 € | 6,195 € | **80,136 €** |
| 2032 | -1,998 € | 75,407 € | 12,387 € | **85,796 €** |
| 2033 | -2,057 € | 77,625 € | 12,751 € | **88,320 €** |
| 2034 | -2,116 € | 79,843 € | 13,116 € | **90,843 €** |
| 2035 | -2,174 € | 82,061 € | 13,480 € | **93,366 €** |
| 2036 | -2,233 € | 84,279 € | 13,844 € | **95,890 €** |
| 2037 | -2,292 € | 86,497 € | 14,209 € | **98,413 €** |
| 2038 | -2,351 € | 88,714 € | 14,573 € | **100,937 €** |
| 2039 | -2,410 € | 90,932 € | 14,937 € | **103,460 €** |
| 2040 | -2,468 € | 93,150 € | 15,302 € | **105,984 €** |

*Table 66: Accident Costs for Alternative 2, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -178 € | 15,161 € | 0 € | **14,982 €** |
| 2031 | -577 € | 31,240 € | 2,335 € | **32,998 €** |
| 2032 | -786 € | 31,249 € | 4,669 € | **35,132 €** |
| 2033 | -810 € | 32,168 € | 4,806 € | **36,165 €** |
| 2034 | -833 € | 33,088 € | 4,944 € | **37,199 €** |
| 2035 | -856 € | 34,007 € | 5,081 € | **38,232 €** |
| 2036 | -879 € | 34,926 € | 5,218 € | **39,265 €** |
| 2037 | -902 € | 35,845 € | 5,356 € | **40,298 €** |
| 2038 | -925 € | 36,764 € | 5,493 € | **41,332 €** |
| 2039 | -948 € | 37,683 € | 5,630 € | **42,365 €** |
| 2040 | -971 € | 38,602 € | 5,768 € | **43,398 €** |

#### 9.5.3.5. Transport time

As was pointed out in section 4.2.3, the travel time influences the value of the cargo at the time of arrival with the consignee. Firstly, capital is tied up and thus constitutes opportunity costs. Secondly, the quality of the transported goods might deteriorate over time. In order to estimate the transportation time differences, the respective additional vehicle kilometres per mode are divided by the respective average speed parameters. The resulting total transport hours per mode are then multiplied with the hourly rates listed in Table 2, i.e. 1.18€ for containerized traffic in combined transport and 0.77€ as the average of the remaining cargo categories for block and wagonload trains, both updated to the 2019 price level (BVWP, 2015).

The transport by rail is slowed down, which is a cost to consignors. The costs were calculated by multiplying the annual remaining tonnes transported on the segment by the hourly rate, the track length of 32 km and the time difference of 12.4 minutes and 29 minutes respectively. The transport by road is generally quicker than by rail, thus a benefit results for the party owning the goods during the transport. The time difference is estimated by comparing the total vehicle kilometres at an average speed of 62 km/h for trucks and 53 km/h for trains.

For barge traffic costs accrue, as inland navigation takes longer than rail transport. An average speed of 16.7 km/h was assumed.

*Table 67: Transportation Time Costs for Alternative 1, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | 264,524 € | -5,667 € | 0 € | **258,857 €** |
| 2031 | 268,680 € | -11,677 € | 104,560 € | **361,562 €** |
| 2032 | 266,533 € | -11,682 € | 209,055 € | **463,906 €** |
| 2033 | 274,372 € | -12,025 € | 215,204 € | **477,551 €** |
| 2034 | 282,211 € | -12,369 € | 221,353 € | **491,195 €** |
| 2035 | 290,050 € | -12,712 € | 227,501 € | **504,839 €** |
| 2036 | 297,889 € | -13,056 € | 233,650 € | **518,484 €** |
| 2037 | 305,729 € | -13,399 € | 239,799 € | **532,128 €** |
| 2038 | 313,568 € | -13,743 € | 245,947 € | **545,772 €** |
| 2039 | 321,407 € | -14,087 € | 252,096 € | **559,416 €** |
| 2040 | 329,246 € | -14,430 € | 258,245 € | **573,061 €** |

*Table 68: Transportation Time Costs for Alternative 2, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | 113,523 € | -2,296 € | 0 € | **111,227 €** |
| 2031 | 116,314 € | -4,732 € | 39,533 € | **151,115 €** |
| 2032 | 115,968 € | -4,733 € | 79,041 € | **190,275 €** |
| 2033 | 119,378 € | -4,873 € | 81,366 € | **195,871 €** |
| 2034 | 122,789 € | -5,012 € | 83,690 € | **201,468 €** |
| 2035 | 126,200 € | -5,151 € | 86,015 € | **207,064 €** |
| 2036 | 129,611 € | -5,290 € | 88,340 € | **212,660 €** |
| 2037 | 133,022 € | -5,430 € | 90,665 € | **218,257 €** |
| 2038 | 136,432 € | -5,569 € | 92,989 € | **223,853 €** |
| 2039 | 139,843 € | -5,708 € | 95,314 € | **229,449 €** |
| 2040 | 143,254 € | -5,847 € | 97,639 € | **235,046 €** |

#### 9.5.3.6. Congestion

Congestion costs are related to the traffic burden imposed on other traffic participants and thus the concept of congestion and the contribution of additional vehicles is reasonable to grasp, but quite difficult to quantify. An attempt to determine marginal congestion costs comes from CE Delft, IFRAS & Fraunhofer ISI, including cost components for the drivers' time loss and additional vehicle operating costs of other participants including fuel (CE Delft, INFRAS, Fraunhofer ISI, 2011). Updated to 2019 price level, they estimate marginal congestion costs of 16.09€ per 1,000 tkm for road transport. Regarding inland shipping, no congestion costs are assumed. Intuitively, waiting times might occur at locks and sluices or passages of shallow water, however no indication could be found with regards to incremental traffic. The reduced traffic on railway tracks causes a benefit as congestion is supposed to decline. It was stated in 7.2 that track capacity was sufficient to accommodate the slower trains which implies that there is no congestion. However, this applies to the specific Meteren – Boxtel section. On the remaining Dutch network, a train reduction can potentially alleviate bottlenecks (e.g. at terminals or border crossings). Therefore, a marginal cost reduction of 0.55€$_{2019}$ per reduction of 1,000 tonne kilometres for freight trains is assumed (RICARDO-AEA, 2014). It must be pointed out that the source does not specify whether there is a difference between day and night time operations. However, the fact that no passenger trains operate in the night hours and thus the traffic density is lower, implies that the marginal benefit should be lower at night. When trains ride slower, the capacity of the network is reduced as the tracks are longer occupied. Therefore, increasing congestion costs for the remaining trains on the Meteren-Boxtel segment should also be accounted for. However, no reasonable assumption could be made regarding this increase.

*Table 69: Congestion Costs for Alternative 1, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -1,033 € | 29,826 € | - | **28,793 €** |
| 2031 | -3,462 € | 61,459 € | - | **57,997 €** |
| 2032 | -4,796 € | 61,479 € | - | **56,683 €** |
| 2033 | -4,937 € | 63,287 € | - | **58,351 €** |
| 2034 | -5,078 € | 65,096 € | - | **60,018 €** |
| 2035 | -5,219 € | 66,904 € | - | **61,685 €** |
| 2036 | -5,360 € | 68,712 € | - | **63,352 €** |
| 2037 | -5,501 € | 70,520 € | - | **65,019 €** |
| 2038 | -5,642 € | 72,328 € | - | **66,686 €** |
| 2039 | -5,783 € | 74,137 € | - | **68,354 €** |
| 2040 | -5,924 € | 75,945 € | - | **70,021 €** |

*Table 70: Congestion Costs for Alternative 2, undiscounted*

| | Rail | Road | Inland Shipping | **Total** |
|---|---|---|---|---|
| 2030 | -428 € | 12,360 € | - | **11,932 €** |
| 2031 | -1,385 € | 25,470 € | - | **24,085 €** |
| 2032 | -1,887 € | 25,477 € | - | **23,590 €** |
| 2033 | -1,943 € | 26,227 € | - | **24,284 €** |
| 2034 | -1,998 € | 26,976 € | - | **24,978 €** |
| 2035 | -2,054 € | 27,725 € | - | **25,671 €** |
| 2036 | -2,109 € | 28,475 € | - | **26,365 €** |
| 2037 | -2,165 € | 29,224 € | - | **27,059 €** |
| 2038 | -2,221 € | 29,973 € | - | **27,753 €** |
| 2039 | -2,276 € | 30,723 € | - | **28,447 €** |
| 2040 | -2,332 € | 31,472 € | - | **29,141 €** |

## 9.6. Conclusion and Sensitivity Analysis: Answer to research sub-question 3

In the following chapter, the single cost elements as presented previously will be compared to each other on a per-year basis for 2030, 2031 and 2032. The remaining numbers are presented in annex 1. After the annual figures, a total summary over the entire planning period follows.

### 9.6.1. Annual Costs and Benefits

The first table shows the total costs and benefits per cost element for alternative 1, a reduction to 40km/h, in the year 2030. Where there is a negative sign, these positions are benefits. Where possible, costs or benefits for rail were split between changes results of the speed reduction and the diverted traffic volumes. Blank positions indicate that a calculation was not possible. In case of infrastructure maintenance, for example, it makes sense to assume that a speed reduction positively affects maintenance costs. However, no feasible estimate could be made.

In 2030, a cost of 359,354 € results from speed reduction measure. The increased operating costs show the most significant change of all elements and are the main contributor to the overall economic disbenefit.

*Table 71: Total Cost and Benefit Summary for Alternative 1 in 2030, undiscounted*

| | Rail (reduced speed) | Rail (lost traffic) | Road | Barge | Total | % of total |
|---|---|---|---|---|---|---|
| Infrastructure Maintenance | | -2,148 € | 14,829 € | 0 € | 12,681 € | 3.5% |
| Operating Costs | 89,953 € | -44,224 € | 80,443 € | 0 € | 126,172 € | 35.1% |
| Travel time | 264,524 € | | -5,667 € | 0 € | 258,857 € | 72.0% |
| Accidents | | -430 € | 36,583 € | 0 € | 36,153 € | 10.1% |
| Noise | -77,682 € | -6,862 € | 14,987 € | 0 € | -69,557 € | -19.4% |
| Air pollution | -11,510 € | -716 € | 6,720 € | 0 € | -5,507 € | -1.5% |
| Climate Change | -37,951 € | -1,309 € | 11,021 € | 0 € | -28,238 € | -7.9% |
| Congestion | | -1,033 € | 29,826 € | 0 € | 28,793 € | 8.0% |
| | | | | | **359,354 €** | 100.0% |

In 2031, a cost of 645,975 € results from speed reduction measure.

*Table 72: Total Cost and Benefit Summary for Alternative 1 in 2031, undiscounted*

| Direct Costs | Rail (reduced speed) | Rail (lost traffic) | Road | Barge | Total | % of total |
|---|---|---|---|---|---|---|
| Infrastructure Maintenance | | -7,198 € | 30,556 € | 842 € | 24,200 € | 3.7% |
| Operating Costs | 90,355 € | -142,589 € | 165,761 € | 79,828 € | 193,355 € | 29.9% |
| Travel time | 268,680 € | | -11,677 € | 104,560 € | 361,562 € | 56.0% |
| Accidents | | -1,443 € | 75,383 € | 6,195 € | 80,136 € | 12.4% |
| | | | | | | |
| Noise | -78,912 € | -23,151 € | 30,883 € | 0 € | -71,180 € | -11.0% |
| Air pollution | -11,692 € | -2,386 € | 13,847 € | 14,212 € | 13,980 € | 2.2% |
| Climate Change | -38,552 € | -4,646 € | 22,711 € | 6,412 € | -14,076 € | -2.2% |
| Congestion | | -3,462 € | 61,459 € | | 57,997 € | 9.0% |
| | | | | | **645,975 €** | 100.0% |

In 2032, a cost of 788,607 € results from speed reduction measure.

*Table 73: Total Cost and Benefit Summary for Alternative 1 in 2032, undiscounted*

| Direct Costs | Rail (reduced speed) | Rail (lost traffic) | Road | Barge | Total | % of total |
|---|---|---|---|---|---|---|
| Infrastructure Maintenance | | -9,971 € | 30,566 € | 1,685 € | 22,280 € | 2.8% |
| Operating Costs | 89,077 € | -194,049 € | 165,814 € | 160,581 € | 221,423 € | 28.1% |
| Travel time | 266,533 € | | -11,682 € | 209,055 € | 463,906 € | 58.8% |
| Accidents | | -1,998 € | 75,407 € | 12,387 € | 85,796 € | 10.9% |
| | | | | | | |
| Noise | -78,282 € | -32,162 € | 30,893 € | 0 € | -79,551 € | -10.1% |
| Air pollution | -11,599 € | -3,296 € | 13,851 € | 28,416 € | 27,373 € | 3.5% |
| Climate Change | -38,244 € | -6,596 € | 22,718 € | 12,820 € | -9,303 € | -1.2% |
| Congestion | | -4,796 € | 61,479 € | | 56,683 € | 7.2% |
| | | | | | **788,607 €** | 100.0% |

For alternative 2, a reduction to 60km/h, the same approach yields the following results. In 2030, a cost of 118,995 € results from speed reduction measure. The higher operating costs for road and rail transport obliterate any benefit achieved.

*Table 74: Total Cost and Benefit Summary for Alternative 2 in 2030, undiscounted*

| Direct Costs | Rail (reduced speed) | Rail (lost traffic) | Road | Barge | Total | % of total |
|---|---|---|---|---|---|---|
| Infrastructure Maintenance | | -890 € | 6,145 € | 0 € | 5,255 € | 4.4% |
| Operating Costs | 38,565 € | -18,420 € | 33,337 € | 0 € | 53,483 € | 44.9% |
| Travel time | 113,523 € | | -2,296 € | 0 € | 111,227 € | 93.5% |
| Accidents | | -178 € | 15,161 € | 0 € | 14,982 € | 12.6% |
| Noise | -41,417 € | -2,854 € | 6,211 € | 0 € | -38,060 € | -32.0% |
| Air pollution | -8,250 € | -297 € | 2,785 € | 0 € | -5,762 € | -4.8% |
| Climate Change | -38,088 € | -542 € | 4,567 € | 0 € | -34,063 € | -28.6% |
| Congestion | | -428 € | 12,360 € | 0 € | 11,932 € | 10.0% |
| | | | | | **118,995 €** | **100.0%** |

In 2031, a cost of 232,807 € results from speed reduction measure.

*Table 75: Total Cost and Benefit Summary for Alternative 2 in 2031, undiscounted*

| Direct Costs | Rail (reduced speed) | Rail (lost traffic) | Road | Barge | Total | % of total |
|---|---|---|---|---|---|---|
| Infrastructure Maintenance | | -2,879 € | 12,663 € | 318 € | 10,101 € | 4.3% |
| Operating Costs | 39,356 € | -57,347 € | 68,694 € | 30,078 € | 80,782 € | 34.7% |
| Travel time | 116,314 € | | -4,732 € | 39,533 € | 151,115 € | 64.9% |
| Accidents | | -577 € | 31,240 € | 2,335 € | 32,998 € | 14.2% |
| Noise | -42,437 € | -9,275 € | 12,799 € | 0 € | -38,914 € | -16.7% |
| Air pollution | -8,453 € | -955 € | 5,738 € | 5,357 € | 1,687 € | 0.7% |
| Climate Change | -39,026 € | -1,851 € | 9,412 € | 2,417 € | -29,048 € | -12.5% |
| Congestion | | -1,385 € | 25,470 € | 0 € | 24,085 € | 10.3% |
| | | | | | **232,807 €** | **100.0%** |

In 2032, a cost of 287,088 € results from speed reduction measure.

*Table 76: Total Cost and Benefit Summary for Alternative 2 in 2032, undiscounted*

| Direct Costs | Rail (reduced speed) | Rail (lost traffic) | Road | Barge | Total | % of total |
|---|---|---|---|---|---|---|
| Infrastructure Maintenance | | -3,924 € | 12,667 € | 635 € | 9,377 € | 3.3% |
| Operating Costs | 39,162 € | -76,738 € | 68,715 € | 60,276 € | 91,415 € | 31.8% |
| Travel time | 115,968 € | | -4,733 € | 79,041 € | 190,275 € | 66.3% |
| Accidents | | -786 € | 31,249 € | 4,669 € | 35,132 € | 12.2% |
| | | | | | | |
| Noise | -42,311 € | -12,670 € | 12,802 € | 0 € | -42,179 € | -14.7% |
| Air pollution | -8,428 € | -1,298 € | 5,740 € | 10,711 € | 6,725 € | 2.3% |
| Climate Change | -38,910 € | -2,584 € | 9,415 € | 4,832 € | -27,247 € | -9.5% |
| Congestion | | -1,887 € | 25,477 € | 0 € | 23,590 € | 8.2% |
| | | | | | **287,088 €** | **100.0%** |

### 9.6.2. Total Costs and Benefits

In the previous chapters, the single cost and benefit elements have been presented as they occur in their respective year of accrual. Due to the time preference of consumption and to balance future uncertainties, future costs and benefits have to be discounted to the present value. In this chapter, the costs and benefit are summarized and discounted to the base year 2019. The discount rate used in this analysis is 5.5%, which the Dutch Bureau for Economic Policy Analysis (CPB) and the Netherlands Environmental Assessment Agency (PBL) unanimously suggest to use in public appraisal projects (Romijn & Renes, 2013).

The discounted cost and benefit elements as presented previously are summed and juxtaposed to determine the feasibility of the project. In the case of alternative 1, the reduction of the allowed speed to 40 km/h, the following aggregate costs and benefits accrue:

*Table 77: Summary of Costs and Benefits for Alternative 1*

| | Costs (C) | | Benefits (B) | | Net Costs (C+B) | |
|---|---|---|---|---|---|---|
| | Total | Discounted | Total | Discounted | Total | Discounted |
| 2030 | 458,933 € | 254,667 € | -99,579 € | -55,257 € | 359,354 € | 199,409 € |
| 2031 | 881,328 € | 463,562 € | -235,353 € | -123,792 € | 645,975 € | 339,771 € |
| 2032 | 1,092,205 € | 544,530 € | -303,598 € | -151,362 € | 788,607 € | 393,169 € |
| 2033 | 1,124,388 € | 531,351 € | -312,527 € | -147,691 € | 811,861 € | 383,661 € |
| 2034 | 1,156,574 € | 518,068 € | -321,456 € | -143,991 € | 835,118 € | 374,077 € |
| 2035 | 1,188,763 € | 504,726 € | -330,386 € | -140,276 € | 858,378 € | 364,451 € |
| 2036 | 1,220,956 € | 491,370 € | -339,315 € | -136,556 € | 881,641 € | 354,813 € |
| 2037 | 1,253,152 € | 478,035 € | -348,244 € | -132,843 € | 904,908 € | 345,192 € |
| 2038 | 1,285,352 € | 464,756 € | -357,174 € | -129,147 € | 928,178 € | 335,610 € |
| 2039 | 1,317,555 € | 451,564 € | -366,103 € | -125,474 € | 951,452 € | 326,090 € |
| 2040 | 1,349,922 € | 438,538 € | -375,032 € | -121,834 € | 974,889 € | 316,704 € |

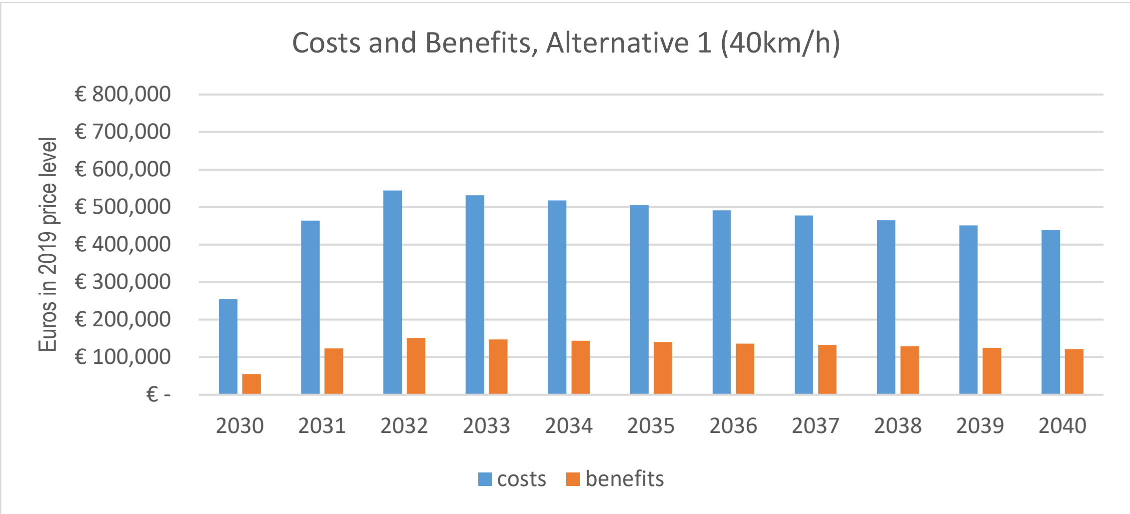


*Figure 30: Costs and Benefits for Alternative 1, discounted*

For alternative 2, both the costs and the benefits are smaller, as the smaller speed reduction leads to a weaker modal shift. Thus, operating costs increase less significantly and external effects are also weaker.

*Table 78: Summary of Costs and Benefits for Alternative 2*

| | Costs (C) | | Benefits (B) | | Net Costs (C+B) | |
|---|---|---|---|---|---|---|
| | Total | Discounted | Total | Discounted | Total | Discounted |
| 2030 | 194,090 € | 107,702 € | -75,095 € | -41,671 € | 118,995 € | 66,032 € |
| 2031 | 362,366 € | 190,598 € | -129,560 € | -68,146 € | 232,807 € | 122,452 € |
| 2032 | 442,196 € | 220,462 € | -155,108 € | -77,331 € | 287,088 € | 143,131 € |
| 2033 | 455,211 € | 215,119 € | -159,670 € | -75,455 € | 295,541 € | 139,663 € |
| 2034 | 468,225 € | 209,734 € | -164,232 € | -73,565 € | 303,993 € | 136,169 € |
| 2035 | 481,240 € | 204,326 € | -168,794 € | -71,667 € | 312,447 € | 132,659 € |
| 2036 | 494,256 € | 198,912 € | -173,356 € | -69,766 € | 320,900 € | 129,145 € |
| 2037 | 507,272 € | 193,507 € | -177,918 € | -67,870 € | 329,354 € | 125,637 € |
| 2038 | 520,289 € | 188,126 € | -182,480 € | -65,981 € | 337,809 € | 122,145 € |
| 2039 | 533,306 € | 182,779 € | -187,042 € | -64,105 € | 346,264 € | 118,675 € |
| 2040 | 545,562 € | 177,232 € | -189,023 € | -61,406 € | 356,539 € | 115,826 € |

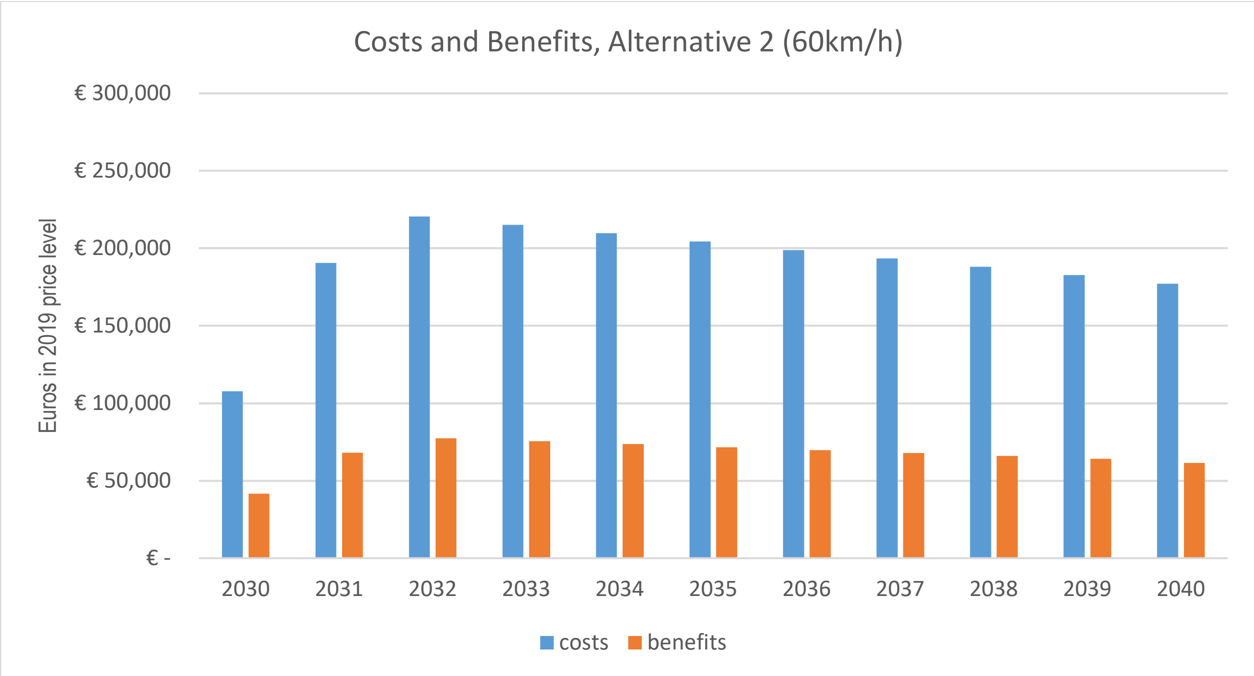


*Figure 31: Costs and Benefits for Alternative 2, discounted*

### 9.6.3. Net Present Value and Benefit/Cost Ratio

Over the entire time horizon, the sum of all discounted costs and all benefits determines the net present value (NPV) of the intended policy of differentiated driving.

There are two main indicators that signal whether a project is economically feasible or not. Firstly, the NPV, which is the sum of all future benefits minus the sum of all future costs, both discounted to today's value. Secondly, the benefit-cost ratio (B/C-ratio), which is calculated by dividing the total discounted future benefits by the total discounted future costs, in absolute terms. If the NPV is positive (which is equal to the B/C-ratio being larger than 1), the project is economically viable.
In both cases, the suggested policy creates costs that largely exceed the benefits expressed in today's values. The benefits created by the noise reduction are the most relevant ones, but as there are only very few other positive effects (mostly coming from time gains by truck transport), they do not suffice to compensate the costs. Research sub-question 3 regarding the impact of the expected modal shift and speed reduction on financial and social costs of freight transportation by rail, waterway and by road transport is answered and quantified by Table 79 below. Accordingly, the NPV is negative and the B/C-ratio is closer to zero than to one. Therefore, the author recommends to reject the suggested speed limit reduction for freight trains by night as suggested in both policy alternatives.

*Table 79: NPV and B/C-Ratio for the Project Alternatives*

| | **A1: 40km/h** | **A2: 60km/h** |
|---|---|---|
| total costs, discounted | -5,141,168 € | -2,088,496 € |
| total benefits, discounted | 1,408,222 € | 736,962 € |
| NPV | -3,732,946 € | -1,351,533 € |
| B/C | 0.274 | 0.353 |

### 9.6.4. Sensitivity Analysis

In a project appraisal process, a sensitivity analysis helps to investigate uncertainties and assess their impact. By identifying and altering critical input variables, the impact on the final result shows under which circumstances an evaluated project can become economically viable or unviable. However, a sensitivity analysis does not only help to assess the potential risk from uncertainties, but it can also identify where a project needs to be improved to reach a feasible outcome.
Looking at the cost and benefit element decomposition for both alternatives, it is clear that longer driving times are the main driver of the costs, accounting for almost half of the costs caused by the policy of differentiated driving. The biggest lever for improvements is suspected to be in value of time and it will be tested first for its impact on the project.

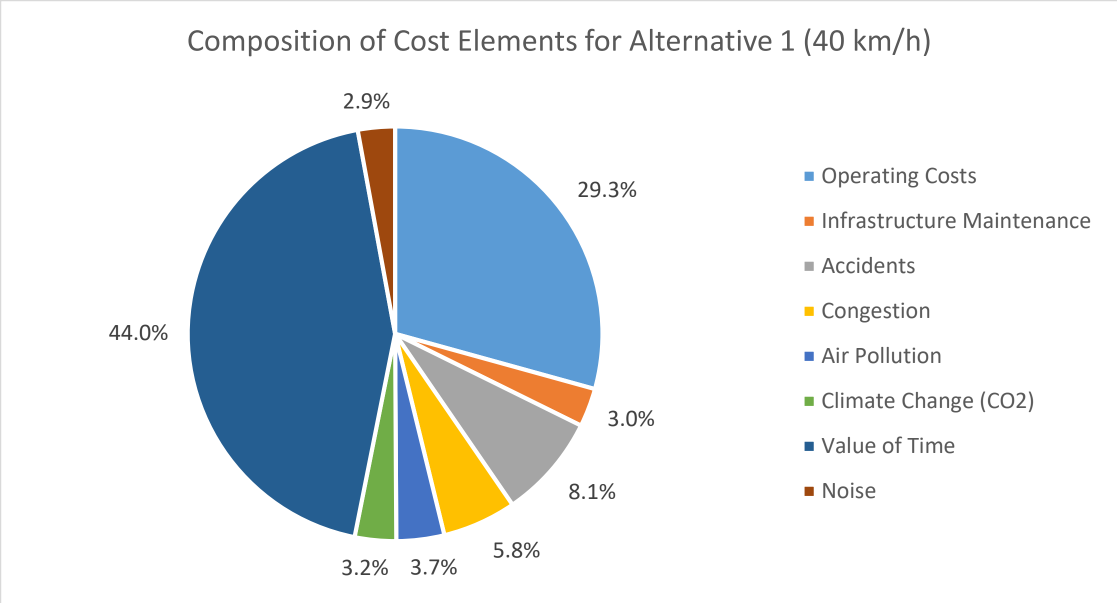


*Figure 32: Cost Elements in Alternative 1*

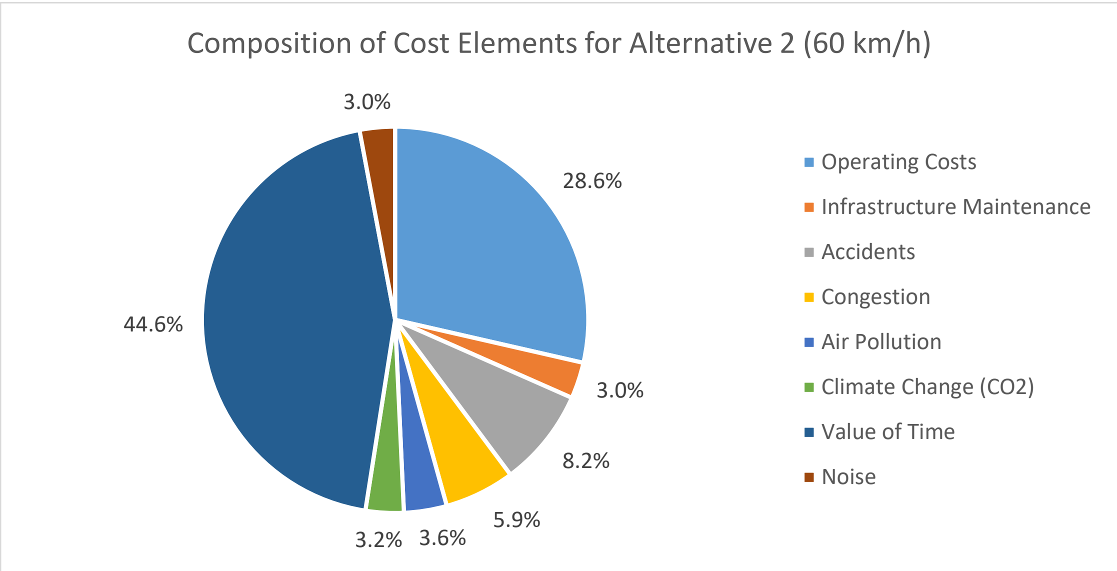


*Figure 33: Cost Elements in Alternative 2*

Assuming that the value of time was significantly overstated, it is now reduced by 50%. This will reduce the costs to consignors for longer travel times by rail (remaining traffic) and barge (shifted volumes), and also slightly reduce the benefits from a shift to the quicker mode of trucking. However, the reduction is not sufficient to render the policy measure economically viable. The NPV improves slightly for both alternatives, but does not reach a positive result. Likewise, the B/C ratio is still significantly below 1.

*Table 80: Policy Results with Reduced Value of Time*

| | A1: 40km/h | A2: 60km/h |
|---|---|---|
| total costs, discounted | - 4,006,861.63 € | -1,621,247.49 € |
| total benefits, discounted | 1,379,930.72 € | 725,498.46 € |
| NPV | -2,626,930.92 € | -895,749.03€ |
| B/C | 0.344 | 0.447 |

The second biggest position in the cost decomposition are operating costs. Assuming that there is an advance in technology that causes all modes to gain efficiency by 2030, 20% of total operating costs are deducted in the calculation. Additionally, in order to account for the advancing awareness for environmental issues, air pollution and climate change costs are reduced by 50%. As a result, the NPV and the B/C ratio deteriorate even further for both alternative policies. These benefit reductions occur as energy savings accounting for larger benefits are reduced in excess of the operating cost gains.

*Table 81: NPV and B/C-Ratio for the Project Alternatives after Technology Improvements*

| | A1: 40km/h | A2: 60km/h |
|---|---|---|
| total costs | -4,770,937 € | -2,066,523 € |
| total benefits | 1,262,693 € | 654,879 € |
| NPV | -3,508,244 € | -1,411,644 € |
| B/C | 0.265 | 0.317 |

Another variable tested in the sensitivity analysis is the assumed net loading weight carried by trucks. As indicated by the source (Eurostat, 2019b), 13 tons are assumed in this study, but a survey on Western Cape weighbridges found a weight of 18 tons in the Western Cape region of South Africa (Swarts, 2019)[32]. A higher net load implies less truck trips and thus less operating and external costs. In total, this alteration improves the final result, albeit only slightly. The B/C ratios increase to 0.294 for alternative 1 and to 0.380 for alternative 2, with NPVs of around -3.4 €m and -1.2 €m respectively. Table 82 summarizes the results of the three options described before.

[32] The data were supplied in an Excel sheet to the researcher via the Department of Logistics, Stellenbosch University.

*Table 82: Summary of Sensitivity Analyses Results*

| | A1 (40 km/h) | A2 (60 km/h) |
|---|---|---|
| **Value of Time Devaluation** | | |
| NPV Total | -2,626,931 € | -895,749 € |
| B/C Total | 0.344 | 0.447 |
| **Operations and Environmental Cost Devaluation** | | |
| NPV Total | -3,508,244 € | -1,411,644 € |
| B/C Total | 0.265 | 0.317 |
| **18 tons Net Truck Load** | | |
| NPV Total | -3,377,953 € | -1,204,421 € |
| B/C Total | 0.294 | 0.380 |
| **Original Results** | | |
| NPV Total | -3,732,946 € | -1,351,533 € |
| B/C Total | 0.274 | 0.353 |

Looking at the benefit side of the equation, noise emissions benefits from reduced railway activity account for the largest proportion, but these are outweighed by increased operating costs from other modes. Comparing the importance of climate change benefits in both alternatives shows that these benefits become relatively more important at higher speeds. This suggests that a smaller decrease of speed, for example to 75 km/h, should also be investigated with respect to costs and benefits.

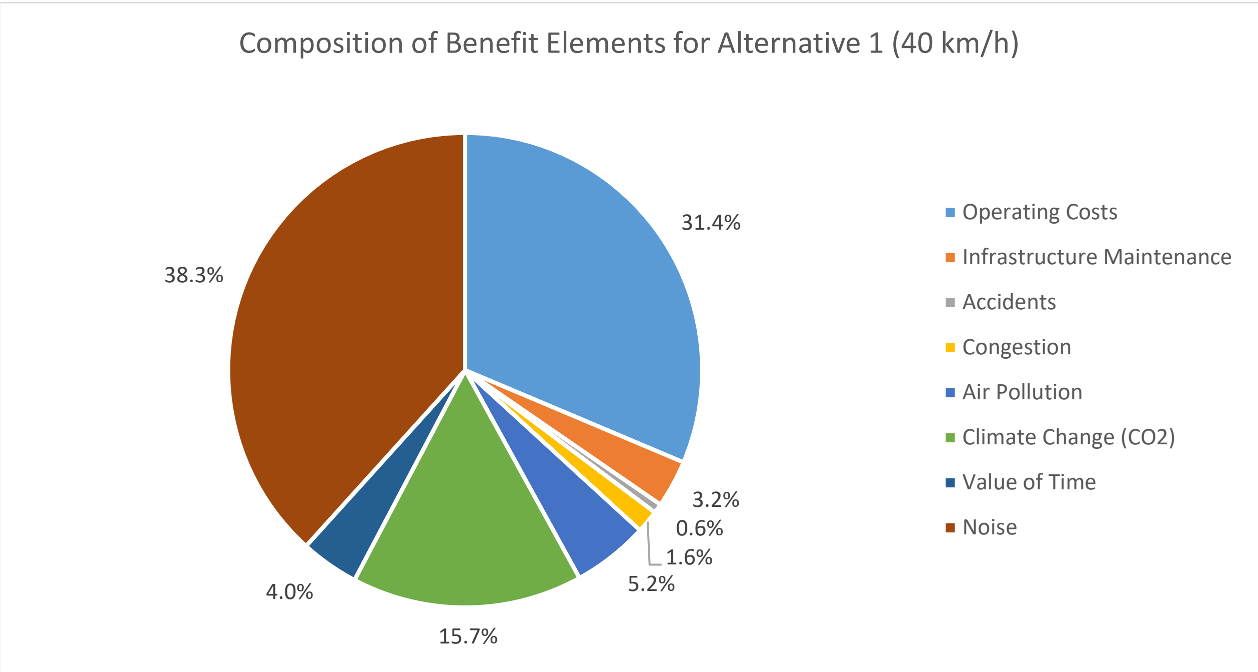


*Figure 34: Benefit Elements in Alternative 1*

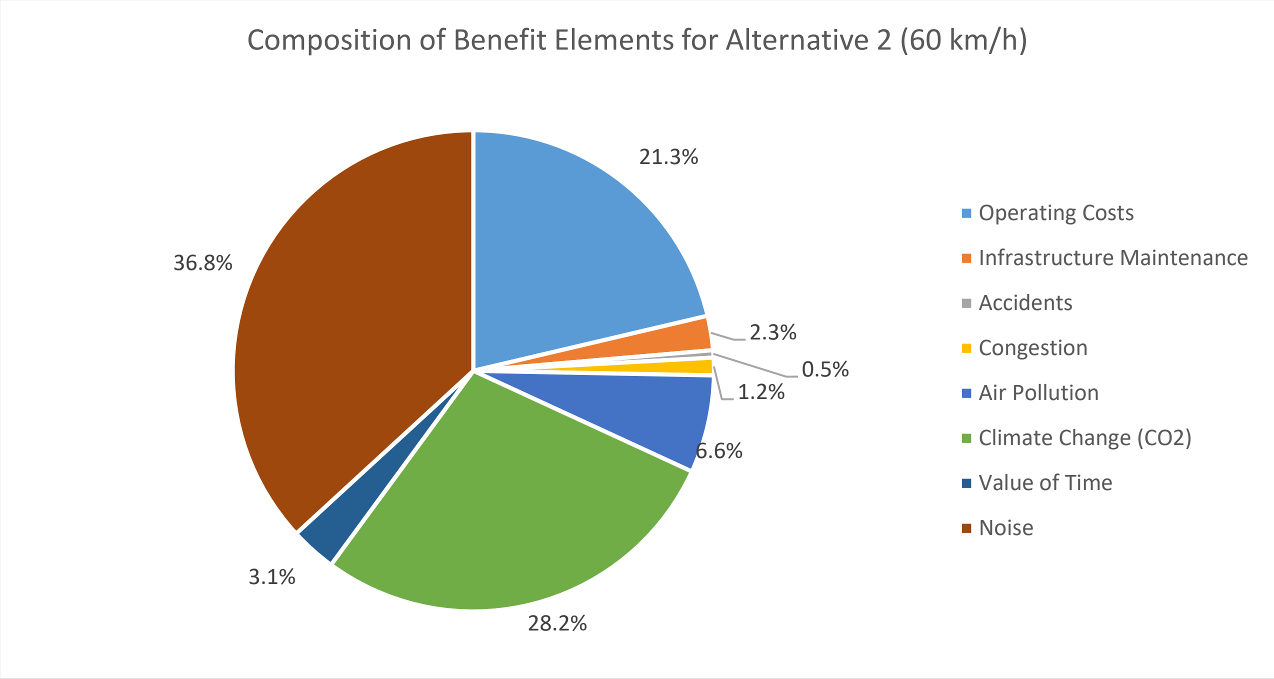


*Figure 35: Benefit Elements in Alternative 2*

However, given the public awareness of noise pollution, there has been a tremendous effort in the past decade to mitigate the disturbance. Different means, such as erecting noise barriers, replacing wooden sleepers by concrete ones, grinding the track to reduce resistance, replacing iron block brakes by quiet composite block, using less noisy engines or better housing insulation, are increasingly being implemented. Thus, it must rather be assumed that the noise problem is going to decrease over time rather than increase, meaning that the noise reduction benefit calculated in this study is rather optimistic than understated. The same holds for the scenario that technology advances and emissions will be reduced. In this case, not only costs, but also benefits will shrink.

## 10. Limitations & Future Research

This study delivered two major components. The first important aspect was the estimation of price elasticities of different freight railway production systems in the Netherlands at different trip distances. A few studies exist that estimate these elasticities for different regions and different scenarios empirically by using extensive computer simulations of traffic stream under different input parameters. Contrary to this theoretical approach, the study at hand approached the topic more practically by interviewing industry experts. These individuals were asked to state their opinion about the reaction to a cost increase of a certain degree for different distance segments and train types. A limitation to this study emerges from the fact that such statements are hard to be generalized. The total modal shift is the sum of individual decisions that have to be made for every single transportation assignment. Such a case-by-case review will inevitably be made on a company level after the policy implementation, but on an ex-ante macro-level, this approach contains many assumptions and generalizations. Furthermore, the context of the study, the proposed legislation of differentiated driving, is politically extremely charged. Therefore, the respondents might have answered the questions with a conscious or unconscious bias, maybe overstating the effects. In order to add value to the study, respondents from other industries could be invited to participate. Barge and truck operators could validate or oppose the estimations given by the respondents from this study to enhance the validity of the calculated elasticities.

The second central aspect in the study was estimating costs and benefits of the speed reduction policy and the following modal shift. Estimating the operating costs for freight trains was a central part of the information required for the expert interviews and modal shift estimation. Furthermore, it builds on a reliable and up-to-date database. The remaining costs and benefits, both of internal and external nature, rely on previous studies from acknowledged institutions, mostly the EU CBA guidelines. However, and this is also true for the elasticity estimation, the timeline required by the entity that initiated the study involves a lot of uncertainty. Neither technological nor political nor any economic developments can be accurately forecast until 2040. Disruptive innovations, such as cargo drones or autonomous vehicles, could potentially be operational on a large scale by 2030, changing the entire understanding of logistics.[33] Climate change awareness might drive the use of rail as a leading mode, increasing acceptance among non-users and thus leading to the renunciation of the noise complaints. Therefore, the author suggests to repeat this kind of study with a more appropriate time horizon, where the development can be estimated more reliably. Furthermore, the scope could be extended to include more respondents to produce a better understanding of the effects of a policy measure such as differentiated driving. This could include competitors (e.g. barge and truck operators), individuals exposed to high noise levels along the rail freight lines or independent experts on traffic externalities and noise emissions.

Likewise, only a linear regression has been used to determine the demand elasticities in this study. Other statistical models, e.g. exponential or logarithmic, could potentially deliver better results and should be considered in future studies.

The trial run that is intended to take place in the second half of 2019 can generate further data. The author recommends to collect these data (e.g. related to noise emissions, true travel time increases or energy consumption) and compare them to this study. A more in-depth stakeholder analysis, e.g. by conducting stated-preference research, can potentially deliver a more concise picture of the policy implications. Different policy approaches could also be a viable option.

Another aspect that is not within the scope of this study is the production loss that might result from the speed limit. Production processes that depend on just-in-time solutions might collapse and the increasing transport costs potentially threaten the profitability of a certain product or service. Value creation could potentially be shifted abroad as additional transport costs tip the balance towards different places of business.

In the introduction, the possibility of a complete ban of cargo night-time operations was briefly discussed. While this is not a viable option, other ways should still be considered. Constructional measures, e.g. by erecting additional and more sophisticated noise barriers or reducing the original emissions from engines and wheels, constitute a possible field of research. Furthermore, regulating the barging and trucking industries should be considered as an addition to the speed limitation of freight trains. This would level the playing field and possibly moderate the modal shift calculated in this study.

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[33] Drones will most likely not be able to carry heavy containers or carts with bulk goods in the near future, but probably small consignments on the urban last mile. This might, to some extent, replace containerized train transports and have an impact on the supply chain.

Concerning the geographic scope, future investigations could focus on the transferability to other countries or areas. Considering the Republic of South Africa, for example, such questions as answered in this study might become more and more relevant in the future. Today, the economic output and the population density are still in a developing stage. As both continue to grow, especially in urban centres[34], trade activities and therefore transport requirements will follow accordingly. As housing and transport, including space-intensive tracks, loading and technical support facilities, compete for the limited available space, externality-related conflicts of interest and the need for trade-offs will become a pressing issue. Furthermore, South Africa's economy relies heavily on freight railways as a mode, as coals, ores and other bulky materials are transported from inland sources to power plants or to coastal regions for further export by deep sea shipping. Thus, the present study can serve as a framework to conduct research into such cases in other regions. The adaption of specific input data (e.g. marginal costs of externalities) to local requirements are a prerequisite, as externalities (e.g. pollution or noise exposure) have a different impact on life quality in areas with a different degree of economic development and preferences.

[34] The urbanization rate in South Africa has risen from 60.6% in 2007 to 65.9% in 2017 (Statista, 2020) while the entire population grew from 40,6 million in 1996 to 51,7 million in 2011 and 55,6 million in 2016 (Statistics South Africa, 2016: 23)

## 11. Conclusion

The current railway noise levels in the agglomeration around the cities of ‘s-Hertogenbosch and Vught frequently cause disturbance with the population, especially during the night times. Thus, the Dutch Ministry of Infrastructure and Water Management commissioned a study to investigate the economic feasibility of a speed limit reduction for freight trains at night on the section running through this agglomeration. The intention is to verify possible noise mitigation effects, but also to explore the accompanying effects this measure might have for both users and non-users alike. The purpose was to quantify the noise mitigation benefits and all resulting operational and social costs.

This study thus presents a cost-benefit analysis of two possible alternatives: imposing a speed limit of 40 km/h for freight trains at night as the first alternative, and imposing a speed limit of 60 km/h for freight trains at night as the second alternative. Both options were compared to the null alternative, which is continuing as to date with no policy changes.

The report sets out by building a cost model for freight trains comparing each alternative, finding the cost increases that would result from the both case alternatives. Depending on the alternative and the train production cluster, the costs increase between 0.3% and 5.0%.

The expert interviews gave an impression of the operational consequences of a speed reduction regulation. While moderate trip time increases can be coped with, there is fear that a successful pilot on a small scale will cause an extension of the scheme. This would result in unforeseeable disadvantages for the railway system with a strong diversion to competing modes. It was found that the combined transport cluster reacts more sensitively to cost increases as there is more competition especially from trucks. Barges could also adopt traffic volumes from block trains that carry bulky and dangerous goods, such as coal, ore or certain chemicals. The elasticities calculated for this specific context vary across train cluster and cost increment, but are mostly between 1 and 2, indicating an elastic demand for freight transport by rail.

Finally, an economic cost-benefit analysis of the speed limit reduction was carried out over the period of 2030 to 2040, with all monetarised effects discounted to the 2019 price level. In no year did the benefits exceed the costs, yielding a negative NPV and a B/C ratio below one. Especially the time loss for goods taking longer by rail and additional operating costs of trucks outweigh any positive effects. Even a sensitivity analysis did not change the picture, neither when mitigating the impact of travel time costs by 50% nor assuming a cut of operating costs by 20%.

The study has shown that the reduction of the nightly freight train speed limit on the 32 km-section between Meteren and Boxtel is economically not beneficial, neither to 40 km/h nor to 60 km/h. The operating cost of all three modes alone obliterate any externality benefit that might be achieved, meaning that the costs are not only merely shifted, but also increased in total. It is therefore recommended to reject the proposed speed limit reduction between Meteren and Boxtel for freight trains at night. As even a trial on such a small scale would have predominantly negative effects, an extension to a national scope is equally not recommended.

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# Appendices

## Appendix 1: Cost-Benefit Analysis

The following tables summarize the costs of the two policy alternatives. Negative values indicate “negative costs”, i.e. benefits. Both discounted and undiscounted results for the two options are presented.

| | Operating Costs | | | Infrastructure Maintenance | | | Accidents | | | Congestion | | | Air Pollution | | | Climate Change ($CO_2$) | | | Value of Time (Freight) | | | Noise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | **Total** |
| **2030** | 45.7 | 80.4 | 0.0 | -2.1 | 14.8 | 0.0 | -0.4 | 36.6 | 0.0 | -1.0 | 29.8 | 0.0 | -12.2 | 6.7 | 0.0 | -39.3 | 11.0 | 0.0 | 264.5 | -5.7 | 0.0 | -84.5 | 15.0 | 0.0 | **359.4** |
| **2031** | -52.2 | 165.8 | 79.8 | -7.2 | 30.6 | 0.8 | -1.4 | 75.4 | 6.2 | -3.5 | 61.5 | 0.0 | -14.1 | 13.8 | 14.2 | -43.2 | 22.7 | 6.4 | 268.7 | -11.7 | 104.6 | -102.1 | 30.9 | 0.0 | **646.0** |
| **2032** | -105.0 | 165.8 | 160.6 | -10.0 | 30.6 | 1.7 | -2.0 | 75.4 | 12.4 | -4.8 | 61.5 | 0.0 | -14.9 | 13.9 | 28.4 | -44.8 | 22.7 | 12.8 | 266.5 | -11.7 | 209.1 | -110.4 | 30.9 | 0.0 | **788.6** |
| **2033** | -108.1 | 170.7 | 165.4 | -10.3 | 31.5 | 1.7 | -2.1 | 77.6 | 12.8 | -4.9 | 63.3 | 0.0 | -15.3 | 14.3 | 29.3 | -46.2 | 23.4 | 13.2 | 274.4 | -12.0 | 215.2 | -113.7 | 31.8 | 0.0 | **811.9** |
| **2034** | -111.1 | 175.6 | 170.1 | -10.6 | 32.4 | 1.8 | -2.1 | 79.8 | 13.1 | -5.1 | 65.1 | 0.0 | -15.8 | 14.7 | 30.1 | -47.5 | 24.1 | 13.6 | 282.2 | -12.4 | 221.4 | -116.9 | 32.7 | 0.0 | **835.1** |
| **2035** | -114.2 | 180.4 | 174.9 | -10.9 | 33.3 | 1.8 | -2.2 | 82.1 | 13.5 | -5.2 | 66.9 | 0.0 | -16.2 | 15.1 | 30.9 | -48.8 | 24.7 | 14.0 | 290.1 | -12.7 | 227.5 | -120.2 | 33.6 | 0.0 | **858.4** |
| **2036** | -117.3 | 185.3 | 179.7 | -11.1 | 34.2 | 1.9 | -2.2 | 84.3 | 13.8 | -5.4 | 68.7 | 0.0 | -16.6 | 15.5 | 31.8 | -50.1 | 25.4 | 14.3 | 297.9 | -13.1 | 233.7 | -123.4 | 34.5 | 0.0 | **881.6** |
| **2037** | -120.4 | 190.2 | 184.5 | -11.4 | 35.1 | 1.9 | -2.3 | 86.5 | 14.2 | -5.5 | 70.5 | 0.0 | -17.1 | 15.9 | 32.6 | -51.4 | 26.1 | 14.7 | 305.7 | -13.4 | 239.8 | -126.7 | 35.4 | 0.0 | **904.9** |
| **2038** | -123.5 | 195.1 | 189.3 | -11.7 | 36.0 | 2.0 | -2.4 | 88.7 | 14.6 | -5.6 | 72.3 | 0.0 | -17.5 | 16.3 | 33.4 | -52.8 | 26.7 | 15.1 | 313.6 | -13.7 | 245.9 | -129.9 | 36.3 | 0.0 | **928.2** |
| **2039** | -126.6 | 200.0 | 194.1 | -12.0 | 36.9 | 2.0 | -2.4 | 90.9 | 14.9 | -5.8 | 74.1 | 0.0 | -18.0 | 16.7 | 34.3 | -54.1 | 27.4 | 15.5 | 321.4 | -14.1 | 252.1 | -133.2 | 37.3 | 0.0 | **951.5** |
| **2040** | -129.7 | 204.8 | 199.1 | -12.3 | 37.8 | 2.1 | -2.5 | 93.2 | 15.3 | -5.9 | 75.9 | 0.0 | -18.4 | 17.1 | 35.1 | -55.4 | 28.1 | 15.8 | 329.2 | -14.4 | 258.2 | -136.4 | 38.2 | 0.0 | **974.9** |

*Table 83: Summary of Cost-Benefit Analysis for Alternative 1, in Thousand Euros, undiscounted*

| | Operating Costs | | | Infrastructure Maintenance | | | Accidents | | | Congestion | | | Air Pollution | | | Climate Change ($CO_2$) | | | Value of Time (Freight) | | | Noise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | **Total** |
| **2030** | -35.9 | 33.3 | 0.0 | -0.9 | 6.1 | 0.0 | -0.2 | 15.2 | 0.0 | -0.4 | 12.4 | 0.0 | -8.5 | 2.8 | 0.0 | -38.6 | 4.6 | 0.0 | 113.5 | -2.3 | 0.0 | -44.3 | 6.2 | 0.0 | **62.9** |
| **2031** | -37.4 | 68.7 | 30.1 | -2.9 | 12.7 | 0.3 | -0.6 | 31.2 | 2.3 | -1.4 | 25.5 | 0.0 | -9.4 | 5.7 | 5.4 | -40.9 | 9.4 | 2.4 | 116.3 | -4.7 | 39.5 | -51.7 | 12.8 | 0.0 | **213.4** |
| **2032** | -37.6 | 68.7 | 60.3 | -3.9 | 12.7 | 0.6 | -0.8 | 31.2 | 4.7 | -1.9 | 25.5 | 0.0 | -9.7 | 5.7 | 10.7 | -41.5 | 9.4 | 4.8 | 116.0 | -4.7 | 79.0 | -55.0 | 12.8 | 0.0 | **287.1** |
| **2033** | -38.7 | 70.7 | 62.1 | -4.0 | 13.0 | 0.7 | -0.8 | 32.2 | 4.8 | -1.9 | 26.2 | 0.0 | -10.0 | 5.9 | 11.0 | -42.7 | 9.7 | 5.0 | 119.4 | -4.9 | 81.4 | -56.6 | 13.2 | 0.0 | **295.5** |
| **2034** | -39.8 | 72.8 | 63.8 | -4.2 | 13.4 | 0.7 | -0.8 | 33.1 | 4.9 | -2.0 | 27.0 | 0.0 | -10.3 | 6.1 | 11.3 | -43.9 | 10.0 | 5.1 | 122.8 | -5.0 | 83.7 | -58.2 | 13.6 | 0.0 | **304.0** |
| **2035** | -40.9 | 74.8 | 65.6 | -4.3 | 13.8 | 0.7 | -0.9 | 34.0 | 5.1 | -2.1 | 27.7 | 0.0 | -10.6 | 6.2 | 11.7 | -45.2 | 10.2 | 5.3 | 126.2 | -5.2 | 86.0 | -59.8 | 13.9 | 0.0 | **312.4** |
| **2036** | -42.0 | 76.8 | 67.4 | -4.4 | 14.2 | 0.7 | -0.9 | 34.9 | 5.2 | -2.1 | 28.5 | 0.0 | -10.9 | 6.4 | 12.0 | -46.4 | 10.5 | 5.4 | 129.6 | -5.3 | 88.3 | -61.4 | 14.3 | 0.0 | **320.9** |
| **2037** | -43.1 | 78.8 | 69.2 | -4.5 | 14.5 | 0.7 | -0.9 | 35.8 | 5.4 | -2.2 | 29.2 | 0.0 | -11.2 | 6.6 | 12.3 | -47.6 | 10.8 | 5.5 | 133.0 | -5.4 | 90.7 | -63.1 | 14.7 | 0.0 | **329.4** |
| **2038** | -44.2 | 80.8 | 71.0 | -4.6 | 14.9 | 0.7 | -0.9 | 36.8 | 5.5 | -2.2 | 30.0 | 0.0 | -11.4 | 6.8 | 12.6 | -48.8 | 11.1 | 5.7 | 136.4 | -5.6 | 93.0 | -64.7 | 15.1 | 0.0 | **337.8** |
| **2039** | -45.3 | 82.9 | 72.8 | -4.7 | 15.3 | 0.8 | -0.9 | 37.7 | 5.6 | -2.3 | 30.7 | 0.0 | -11.7 | 6.9 | 12.9 | -50.0 | 11.4 | 5.8 | 139.8 | -5.7 | 95.3 | -66.3 | 15.4 | 0.0 | **346.3** |
| **2040** | -46.4 | 84.9 | 74.6 | -2.3 | 15.6 | 0.0 | -1.0 | 38.6 | 5.8 | -2.3 | 31.5 | 0.0 | -12.0 | 7.1 | 13.2 | -51.3 | 11.6 | 6.0 | 143.3 | -5.8 | 97.6 | -67.9 | 15.8 | 0.0 | **356.5** |

*Table 84: Summary of Cost-Benefit Analysis for Alternative 2, in Thousand Euros, undiscounted*

| | Operating Costs | | | Infrastructure Maintenance | | | Accidents | | | Congestion | | | Air Pollution | | | Climate Change ($CO_2$) | | | Value of Time (Freight) | | | Noise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | **Total** |
| **2030** | 25.4 | 44.6 | 0.0 | -1.2 | 8.2 | 0.0 | -0.2 | 20.3 | 0.0 | -0.6 | 16.6 | 0.0 | -6.8 | 3.7 | 0.0 | -21.8 | 6.1 | 0.0 | 146.8 | -3.1 | 0.0 | -46.9 | 8.3 | 0.0 | **199.4** |
| **2031** | -27.5 | 87.2 | 42.0 | -3.8 | 16.1 | 0.4 | -0.8 | 39.7 | 3.3 | -1.8 | 32.3 | 0.0 | -7.4 | 7.3 | 7.5 | -22.7 | 11.9 | 3.4 | 141.3 | -6.1 | 55.0 | -53.7 | 16.2 | 0.0 | **339.8** |
| **2032** | -52.3 | 82.7 | 80.1 | -5.0 | 15.2 | 0.8 | -1.0 | 37.6 | 6.2 | -2.4 | 30.7 | 0.0 | -7.4 | 6.9 | 14.2 | -22.4 | 11.3 | 6.4 | 132.9 | -5.8 | 104.2 | -55.1 | 15.4 | 0.0 | **393.2** |
| **2033** | -51.1 | 80.7 | 78.1 | -4.9 | 14.9 | 0.8 | -1.0 | 36.7 | 6.0 | -2.3 | 29.9 | 0.0 | -7.2 | 6.7 | 13.8 | -21.8 | 11.1 | 6.2 | 129.7 | -5.7 | 101.7 | -53.7 | 15.0 | 0.0 | **383.7** |
| **2034** | -49.8 | 78.6 | 76.2 | -4.7 | 14.5 | 0.8 | -0.9 | 35.8 | 5.9 | -2.3 | 29.2 | 0.0 | -7.1 | 6.6 | 13.5 | -21.3 | 10.8 | 6.1 | 126.4 | -5.5 | 99.2 | -52.4 | 14.7 | 0.0 | **374.1** |
| **2035** | -48.5 | 76.6 | 74.3 | -4.6 | 14.1 | 0.8 | -0.9 | 34.8 | 5.7 | -2.2 | 28.4 | 0.0 | -6.9 | 6.4 | 13.1 | -20.7 | 10.5 | 5.9 | 123.1 | -5.4 | 96.6 | -51.0 | 14.3 | 0.0 | **364.5** |
| **2036** | -47.2 | 74.6 | 72.3 | -4.5 | 13.7 | 0.8 | -0.9 | 33.9 | 5.6 | -2.2 | 27.7 | 0.0 | -6.7 | 6.2 | 12.8 | -20.2 | 10.2 | 5.8 | 119.9 | -5.3 | 94.0 | -49.7 | 13.9 | 0.0 | **354.8** |
| **2037** | -45.9 | 72.6 | 70.4 | -4.4 | 13.4 | 0.7 | -0.9 | 33.0 | 5.4 | -2.1 | 26.9 | 0.0 | -6.5 | 6.1 | 12.4 | -19.6 | 9.9 | 5.6 | 116.6 | -5.1 | 91.5 | -48.3 | 13.5 | 0.0 | **345.2** |
| **2038** | -44.7 | 70.5 | 68.5 | -4.2 | 13.0 | 0.7 | -0.8 | 32.1 | 5.3 | -2.0 | 26.2 | 0.0 | -6.3 | 5.9 | 12.1 | -19.1 | 9.7 | 5.5 | 113.4 | -5.0 | 88.9 | -47.0 | 13.1 | 0.0 | **335.6** |
| **2039** | -43.4 | 68.5 | 66.5 | -4.1 | 12.6 | 0.7 | -0.8 | 31.2 | 5.1 | -2.0 | 25.4 | 0.0 | -6.2 | 5.7 | 11.7 | -18.5 | 9.4 | 5.3 | 110.2 | -4.8 | 86.4 | -45.6 | 12.8 | 0.0 | **326.1** |
| **2040** | -42.1 | 66.5 | 64.7 | -4.0 | 12.3 | 0.7 | -0.8 | 30.3 | 5.0 | -1.9 | 24.7 | 0.0 | -6.0 | 5.6 | 11.4 | -18.0 | 9.1 | 5.1 | 107.0 | -4.7 | 83.9 | -44.3 | 12.4 | 0.0 | **316.7** |

*Table 85: Summary of Cost-Benefit Analysis for Alternative 1, in Thousand Euros, discounted*

| Operating Costs | | | Infrastructure Maintenance | | | Accidents | | | Congestion | | | Air Pollution | | | Climate Change ($CO_2$) | | | Value of Time (Freight) | | | Noise | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | Rail | Road | Barge | **Total** |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2030** | -19.9 | 18.5 | 0.0 | -0.5 | 3.4 | 0.0 | -0.1 | 8.4 | 0.0 | -0.2 | 6.9 | 0.0 | -4.7 | 1.5 | 0.0 | -21.4 | 2.5 | 0.0 | 63.0 | -1.3 | 0.0 | -24.6 | 3.4 | 0.0 | **34.9** |
| **2031** | -19.7 | 36.1 | 15.8 | -1.5 | 6.7 | 0.2 | -0.3 | 16.4 | 1.2 | -0.7 | 13.4 | 0.0 | -4.9 | 3.0 | 2.8 | -21.5 | 5.0 | 1.3 | 61.2 | -2.5 | 20.8 | -27.2 | 6.7 | 0.0 | **112.3** |
| **2032** | -18.7 | 34.3 | 30.1 | -2.0 | 6.3 | 0.3 | -0.4 | 15.6 | 2.3 | -0.9 | 12.7 | 0.0 | -4.8 | 2.9 | 5.3 | -20.7 | 4.7 | 2.4 | 57.8 | -2.4 | 39.4 | -27.4 | 6.4 | 0.0 | **143.1** |
| **2033** | -18.3 | 33.4 | 29.3 | -1.9 | 6.2 | 0.3 | -0.4 | 15.2 | 2.3 | -0.9 | 12.4 | 0.0 | -4.7 | 2.8 | 5.2 | -20.2 | 4.6 | 2.4 | 56.4 | -2.3 | 38.5 | -26.7 | 6.2 | 0.0 | **139.7** |
| **2034** | -17.8 | 32.6 | 28.6 | -1.9 | 6.0 | 0.3 | -0.4 | 14.8 | 2.2 | -0.9 | 12.1 | 0.0 | -4.6 | 2.7 | 5.1 | -19.7 | 4.5 | 2.3 | 55.0 | -2.2 | 37.5 | -26.1 | 6.1 | 0.0 | **136.2** |
| **2035** | -17.4 | 31.7 | 27.9 | -1.8 | 5.9 | 0.3 | -0.4 | 14.4 | 2.2 | -0.9 | 11.8 | 0.0 | -4.5 | 2.7 | 4.9 | -19.2 | 4.3 | 2.2 | 53.6 | -2.2 | 36.5 | -25.4 | 5.9 | 0.0 | **132.7** |
| **2036** | -16.9 | 30.9 | 27.1 | -1.8 | 5.7 | 0.3 | -0.4 | 14.1 | 2.1 | -0.8 | 11.5 | 0.0 | -4.4 | 2.6 | 4.8 | -18.7 | 4.2 | 2.2 | 52.2 | -2.1 | 35.6 | -24.7 | 5.8 | 0.0 | **129.1** |
| **2037** | -16.4 | 30.1 | 26.4 | -1.7 | 5.5 | 0.3 | -0.3 | 13.7 | 2.0 | -0.8 | 11.1 | 0.0 | -4.3 | 2.5 | 4.7 | -18.2 | 4.1 | 2.1 | 50.7 | -2.1 | 34.6 | -24.1 | 5.6 | 0.0 | **125.6** |
| **2038** | -16.0 | 29.2 | 25.7 | -1.7 | 5.4 | 0.3 | -0.3 | 13.3 | 2.0 | -0.8 | 10.8 | 0.0 | -4.1 | 2.4 | 4.6 | -17.7 | 4.0 | 2.1 | 49.3 | -2.0 | 33.6 | -23.4 | 5.4 | 0.0 | **122.1** |
| **2039** | -15.5 | 28.4 | 24.9 | -1.6 | 5.2 | 0.3 | -0.3 | 12.9 | 1.9 | -0.8 | 10.5 | 0.0 | -4.0 | 2.4 | 4.4 | -17.1 | 3.9 | 2.0 | 47.9 | -2.0 | 32.7 | -22.7 | 5.3 | 0.0 | **118.7** |
| **2040** | -15.1 | 27.6 | 24.2 | -0.7 | 5.1 | 0.0 | -0.3 | 12.5 | 1.9 | -0.8 | 10.2 | 0.0 | -3.9 | 2.3 | 4.3 | -16.7 | 3.8 | 1.9 | 46.5 | -1.9 | 31.7 | -22.1 | 5.1 | 0.0 | **115.8** |

*Table 86: Summary of Cost-Benefit Analysis for Alternative 2, in Thousand Euros, discounted*

## Appendix 2: Summary Statistics of the Elasticity Regressions

### Appendix 2.1: Combined Transport

| cost increase | short | medium | long |
|---|---|---|---|
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 1.75 | 0.00 | 0.00 |
| 5% | 2.00 | 1.00 | 1.00 |
| 10% | 1.75 | 1.50 | 1.25 |
| 15% | 1.67 | 1.50 | 1.33 |
| 20% | 1.88 | 1.75 | 1.38 |
| 30% | 2.22 | 1.67 | 1.17 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 1.00 | 1.00 |
| 5% | 2.50 | 1.50 | 1.50 |
| 10% | 2.00 | 1.50 | 1.50 |
| 15% | 2.00 | 1.67 | 1.67 |
| 20% | 2.50 | 1.88 | 1.88 |
| 30% | 2.50 | 1.67 | 1.67 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 3.75 | 2.50 | 2.50 |
| 5% | 3.00 | 2.00 | 2.00 |
| 10% | 2.25 | 2.00 | 2.00 |
| 15% | 2.33 | 2.00 | 2.00 |
| 20% | 2.50 | 2.50 | 2.50 |
| 30% | 3.33 | 2.83 | 2.00 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 0.50 | 0.00 |
| 5% | 3.00 | 2.00 | 1.00 |
| 10% | 2.00 | 1.50 | 1.25 |
| 15% | 2.33 | 1.67 | 1.33 |
| 20% | 2.50 | 1.75 | 1.25 |
| 30% | 2.50 | 2.00 | 1.67 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 1.25 | 0.50 |
| 5% | 2.50 | 2.00 | 0.70 |
| 10% | 2.00 | 1.50 | 1.00 |
| 15% | 2.00 | 1.50 | 1.33 |
| 20% | 2.50 | 1.75 | 1.50 |
| 30% | 2.50 | 1.67 | 1.50 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 0.00 | 0.00 | 0.00 |
| 5% | 1.00 | 0.50 | 0.30 |
| 10% | 1.25 | 1.00 | 0.75 |
| 15% | 1.50 | 1.67 | 1.00 |
| 20% | 2.00 | 1.50 | 1.25 |
| 30% | 2.00 | 1.33 | 1.17 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 0.00 | 0.00 | 0.00 |
| 5% | 1.50 | 1.00 | 0.50 |
| 10% | 1.50 | 1.00 | 0.50 |
| 15% | 2.00 | 1.67 | 1.00 |
| 20% | 2.50 | 1.75 | 1.50 |
| 30% | 3.33 | 3.33 | 1.67 |

| | | | |
|---|---|---|---|
| 1% | 2.00 | 0.00 | 0.00 |
| 2% | 2.50 | 1.00 | 1.00 |
| 5% | 2.50 | 2.00 | 1.50 |
| 10% | 2.25 | 1.50 | 1.50 |
| 15% | 2.33 | 2.00 | 1.67 |
| 20% | 2.50 | 2.25 | 1.75 |
| 30% | 2.83 | 2.00 | 1.33 |
| 1% | 1.00 | 0.00 | 0.00 |
| 2% | 1.00 | 0.00 | 0.00 |
| 5% | 1.00 | 1.00 | 1.00 |
| 10% | 2.00 | 1.00 | 1.00 |
| 15% | 2.00 | 1.00 | 1.00 |
| 20% | 2.00 | 1.00 | 1.00 |
| 30% | 2.00 | 1.00 | 1.00 |

**SUMMARY OUTPUT**
**Short**

| *Regressions Statistics* | |
|---|---|
| Multiple R | 0.509 |
| R Square | 0.259 |
| Adjusted R Square | 0.247 |
| Standard Error | 0.812 |
| Observations | 63 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 14.053 | 14.053 | 21.295 | 0.000 |
| Residue | 61 | 40.254 | 0.660 | | |
| Total | 62 | 54.306 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 1.297 | 0.161 | 8.070 | 0.000 | 0.976 | 1.619 | 0.976 | 1.619 |
| cost increase | 4.824 | 1.045 | 4.615 | 0.000 | 2.734 | 6.915 | 2.734 | 6.915 |

**SUMMARY OUTPUT**
**Medium**

| *Regressions Statistics* | |
|---|---|
| Multiple R | 0.643 |
| R Square | 0.413 |

| | |
|---|---|
| Adjusted R Square | 0.403 |
| Standard Error | 0.630 |
| Observations | 63 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 17.059 | 17.059 | 42.913 | 0.000 |
| Residue | 61 | 24.249 | 0.398 | | |
| Total | 62 | 41.309 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.640 | 0.125 | 5.131 | 0.000 | 0.391 | 0.890 | 0.391 | 0.890 |
| cost increase | 5.315 | 0.811 | 6.551 | 0.000 | 3.693 | 6.938 | 3.693 | 6.938 |

**SUMMARY OUTPUT**
**Long**

| *Regressions Statistics* | |
|---|---|
| Multiple R | 0.604 |
| R Square | 0.365 |
| Adjusted R Square | 0.355 |
| Standard Error | 0.559 |
| Observations | 63 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significanc e F* |
|---|---|---|---|---|---|
| Regression | 1 | 10.961 | 10.961 | 35.053 | 0.000 |
| Residue | 61 | 19.074 | 0.313 | | |
| Total | 62 | 30.035 | | | |

| | *Coefficient s* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.523 | 0.111 | 4.723 | 0.000 | 0.301 | 0.744 | 0.301 | 0.744 |
| cost increase | 4.261 | 0.720 | 5.921 | 0.000 | 2.822 | 5.700 | 2.822 | 5.700 |

Appendix 2.2: Block Trains

| cost increase | short | medium | long |
|---|---|---|---|
| 1% | 0.00 | | 0.00 |
| 2% | 2.25 | | 0.50 |
| 5% | 2.00 | | 0.60 |
| 10% | 2.50 | | 0.75 |
| 15% | 3.33 | | 1.00 |
| 20% | 3.75 | | 1.25 |
| 30% | 2.50 | | 1.00 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 2.50 | 0.00 |
| 5% | 2.00 | 2.00 | 1.00 |
| 10% | 3.00 | 3.33 | 1.25 |
| 15% | 3.67 | 3.33 | 1.67 |
| 20% | 5.00 | 3.33 | 1.67 |
| 30% | 3.33 | 2.50 | 1.67 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 0.00 | 0.00 | 0.00 |
| 5% | 0.00 | 0.90 | 0.50 |
| 10% | 1.50 | 1.50 | 1.00 |
| 15% | 1.67 | 1.50 | 1.00 |
| 20% | 1.88 | 1.63 | 1.25 |
| 30% | 1.67 | 1.42 | 1.11 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 1.25 | 0.00 |
| 5% | 2.50 | 1.00 | 0.50 |
| 10% | 2.50 | 1.25 | 0.75 |
| 15% | 2.67 | 1.67 | 1.00 |
| 20% | 3.75 | 1.75 | 1.25 |
| 30% | 2.50 | 1.67 | 0.83 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 1.75 | 1.00 |
| 5% | 3.00 | 2.00 | 1.30 |
| 10% | 2.50 | 1.50 | 1.35 |
| 15% | 2.22 | 1.67 | 1.33 |
| 20% | 2.50 | 1.67 | 1.67 |
| 30% | 2.50 | 1.67 | 1.67 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 2.50 | 1.25 |
| 5% | 2.50 | 2.50 | 1.00 |
| 10% | 2.00 | 2.00 | 1.00 |
| 15% | 2.22 | 2.22 | 1.00 |
| 20% | 2.50 | 2.50 | 1.00 |
| 30% | 1.67 | 1.67 | 1.00 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 1.00 | 0.00 | 0.00 |
| 5% | 0.90 | 0.50 | 0.50 |
| 10% | 1.50 | 1.00 | 0.75 |
| 15% | 1.50 | 1.17 | 0.83 |
| 20% | 1.67 | 1.25 | 1.00 |
| 30% | 1.83 | 1.50 | 1.25 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 0.00 | 0.00 | 0.00 |

| | | | |
|---|---|---|---|
| 5% | 1.00 | 1.00 | 0.40 |
| 10% | 1.25 | 0.85 | 0.50 |
| 15% | 1.33 | 0.83 | 0.67 |
| 20% | 1.67 | 1.00 | 0.75 |
| 30% | 1.67 | 1.17 | 0.83 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 0.00 | 0.00 | 0.00 |
| 5% | 1.50 | 1.00 | 0.50 |
| 10% | 1.25 | 1.00 | 0.50 |
| 15% | 1.33 | 1.00 | 0.67 |
| 20% | 1.25 | 1.00 | 0.75 |
| 30% | 1.67 | 1.00 | 0.83 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 1.25 | 0.00 | 0.00 |
| 5% | 1.30 | 1.00 | 0.50 |
| 10% | 1.35 | 1.10 | 0.75 |
| 15% | 1.67 | 1.33 | 1.00 |
| 20% | 1.67 | 1.50 | 1.25 |
| 30% | 1.67 | 1.67 | 1.08 |

**SUMMARY OUTPUT**
**Short**

| *Regressions Statistics* | |
|---|---|
| Multiple R | 0.478 |
| R Square | 0.228 |
| Adjusted R Square | 0.217 |
| Standard Error | 0.991 |
| Observations | 70 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 19.766 | 19.766 | 20.127 | 0.000 |
| Residue | 68 | 66.780 | 0.982 | | |
| Total | 69 | 86.547 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 1.053 | 0.186 | 5.661 | 0.000 | 0.682 | 1.424 | 0.682 | 1.424 |
| cost increase | 5.428 | 1.210 | 4.486 | 0.000 | 3.014 | 7.842 | 3.014 | 7.842 |

**SUMMARY OUTPUT**
**Medium**

| *Regressions Statistics* | |
|---|---|
| Multiple R | 0.688 |

| | |
|---|---|
| R Square | 0.473 |
| Adjusted R Square | 0.464 |
| Standard Error | 0.386 |
| Observations | 63 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 8.173 | 8.173 | 54.761 | 0.000 |
| Residue | 61 | 9.104 | 0.149 | | |
| Total | 62 | 17.277 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.299 | 0.076 | 3.912 | 0.000 | 0.146 | 0.452 | 0.146 | 0.452 |
| cost increase | 3.679 | 0.497 | 7.400 | 0.000 | 2.685 | 4.673 | 2.685 | 4.673 |

**SUMMARY OUTPUT**
**Long**

| *Regressions Statistics* | |
|---|---|
| Multiple R | 0.694 |
| R Square | 0.482 |
| Adjusted R Square | 0.474 |
| Standard Error | 0.373 |
| Observations | 70 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 8.814 | 8.814 | 63.208 | 0.000 |
| Residue | 68 | 9.482 | 0.139 | | |
| Total | 69 | 18.296 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.305 | 0.070 | 4.348 | 0.000 | 0.165 | 0.445 | 0.165 | 0.445 |
| cost increase | 3.625 | 0.456 | 7.950 | 0.000 | 2.715 | 4.534 | 2.715 | 4.534 |

# Appendix 2.3: Wagonload Trains

| cost increase | short | medium | long |
|---|---|---|---|
| 1% | 2.00 | 2.00 | 0.00 |
| 2% | 2.50 | 2.50 | 0.00 |
| 5% | 2.00 | 2.00 | 0.40 |
| 10% | 1.25 | 1.25 | 1.00 |
| 15% | 1.67 | 1.67 | 1.33 |
| 20% | 2.00 | 2.00 | 1.50 |
| 30% | 1.67 | 1.67 | 1.33 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 2.50 | 0.00 |
| 5% | 2.50 | 2.00 | 0.60 |
| 10% | 2.00 | 1.50 | 0.50 |
| 15% | 2.67 | 1.33 | 0.67 |
| 20% | 2.50 | 1.75 | 1.00 |
| 30% | 2.33 | 1.67 | 1.00 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 0.00 | 0.00 | 0.00 |
| 5% | 2.00 | 1.00 | 1.00 |
| 10% | 1.50 | 1.00 | 1.50 |
| 15% | 2.33 | 1.00 | 1.33 |
| 20% | 2.50 | 1.25 | 1.75 |
| 30% | 2.50 | 1.00 | 1.50 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 1.25 | 0.00 |
| 5% | 2.00 | 1.00 | 0.40 |
| 10% | 1.75 | 0.75 | 0.50 |
| 15% | 2.00 | 0.83 | 0.67 |
| 20% | 2.38 | 0.75 | 1.50 |
| 30% | 2.33 | 1.00 | 1.67 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 1.50 | 1.00 | 0.50 |
| 5% | 1.50 | 1.50 | 1.00 |
| 10% | 1.00 | 1.00 | 1.00 |
| 15% | 1.17 | 1.17 | 1.00 |
| 20% | 1.50 | 1.50 | 1.00 |
| 30% | 1.50 | 1.50 | 1.00 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 1.25 | 0.00 | 0.00 |
| 5% | 1.00 | 0.50 | 0.00 |
| 10% | 0.75 | 0.50 | 0.50 |
| 15% | 0.67 | 0.67 | 0.50 |
| 20% | 0.75 | 0.75 | 0.75 |
| 30% | 0.83 | 0.83 | 0.67 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 2.50 | 1.00 | 0.00 |
| 5% | 2.00 | 1.00 | 0.50 |
| 10% | 1.50 | 1.25 | 0.75 |
| 15% | 1.67 | 1.33 | 0.67 |
| 20% | 1.75 | 1.50 | 1.00 |
| 30% | 1.67 | 1.33 | 1.17 |
| 1% | 0.00 | 0.00 | 0.00 |
| 2% | 0.00 | 0.00 | 0.00 |

| | | | |
|---|---|---|---|
| 5% | 1.00 | 0.50 | 0.00 |
| 10% | 0.75 | 0.75 | 0.50 |
| 15% | 1.33 | 1.00 | 0.50 |
| 20% | 1.50 | 1.25 | 0.63 |
| 30% | 1.67 | 1.08 | 0.83 |

**SUMMARY OUTPUT**
**Short**

| *Regressions Statistics* | |
|---|---|
| Multiple R | 0.360 |
| R Square | 0.130 |
| Adjusted R Square | 0.114 |
| Standard Error | 0.788 |
| Observations | 56 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 4.995 | 4.995 | 8.050 | 0.006 |
| Residue | 54 | 33.506 | 0.620 | | |
| Total | 55 | 38.501 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 1.105 | 0.165 | 6.682 | 0.000 | 0.773 | 1.436 | 0.773 | 1.436 |
| cost increase | 3.051 | 1.075 | 2.837 | 0.006 | 0.895 | 5.207 | 0.895 | 5.207 |

**SUMMARY OUTPUT**
**Medium**

*Regressions Statistics*

| | |
|---|---|
| Multiple R | 0.326 |
| R Square | 0.106 |
| Adjusted R Square | 0.090 |
| Standard Error | 0.623 |
| Observations | 56 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 2.495 | 2.495 | 6.431 | 0.014 |
| Residue | 54 | 20.953 | 0.388 | | |
| Total | 55 | 23.448 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.773 | 0.131 | 5.909 | 0.000 | 0.510 | 1.035 | 0.510 | 1.035 |
| cost increase | 2.156 | 0.850 | 2.536 | 0.014 | 0.452 | 3.861 | 0.452 | 3.861 |

**SUMMARY OUTPUT Long**

| *Regressions Statistics* | |
|---|---|
| Multiple R | 0.755 |
| R Square | 0.571 |
| Adjusted R Square | 0.563 |
| Standard Error | 0.352 |
| Observations | 56 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 8.878 | 8.878 | 71.749 | 0.000 |
| Residue | 54 | 6.682 | 0.124 | | |
| Total | 55 | 15.561 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95%* | *Upper 95%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.154 | 0.074 | 2.080 | 0.042 | 0.006 | 0.302 | 0.006 | 0.302 |
| cost increase | 4.067 | 0.480 | 8.470 | 0.000 | 3.105 | 5.030 | 3.105 | 5.030 |

**Appendix 3: Questionnaire**

Appendix 3.1: Railway Operators

# Questionnaire: Differentiated Driving – Introduction of a Speed Limit for Freight Trains

*Name:* ______________________________

*Position/Function:* ______________________________

*Company:* ______________________________

*Phone:* ______________________________

*Date:* ______________________________

*Signature:* ______________________________

**Privacy policy disclaimer:**

All Data will be treated as strictly confidential and will be only used for the purpose of this study. The purpose of the study is the preparation of a master's thesis by Christopher Bingel, University of Stellenbosch, in cooperation with Railistics GmbH, Wiesbaden. With the signature above I agree to the use of the data provided in the scope of the study.

## Modal Choice

1. *Which types of goods does your company mainly transport? Please estimate your company's transport volumes (per year) by type (if possible in absolute numbers, e.g. in tonne kilometres, otherwise as a percentage)*

| | |
|---|---|
| Dry bulk (coal, ore, sand, timber, waste, grain…) | |
| Liquid bulk (oil, petroleum, gas, chemicals,…) | |
| Containerized goods / intermodal | |
| Break bulk (e.g. machinery, steel collies, timber) | |
| Others: *please specify* | |

2. *From what type of industry do your customers come? Please estimate your company's transport volumes by industry (if possible in absolute numbers, e.g. in tonne kilometres, otherwise as a percentage)*

| | |
|---|---|
| Container Forwarders | |
| Chemical industry | |
| Automotive | |
| Agricultural | |
| Petroleum | |
| Mining / steel industry | |
| Others: *please specify* | |
| | |
| | |

| | |
|---|---|
| | |
| | |
| | |

3. *What are your company's annual transport volumes by railway freight segment?*

| **Segment** | **Volume in tonne kilometres** |
|---|---|
| Block trains | |
| Combined Transport | |
| Wagonload Trains | |

4. *What are your most important origin-destination relations and their respective volumes per annum?*

| **Origin** | **Destination** | **volume in tonne kilometres** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

5. *What are typical distances for the different segments? Please indicate what percentage the different distances account for in the respective train segment.*
*Each segment (block, combined, wagonload) should be seen separately and add up to 100%*

| | **Block trains** | **Combined transport** | **Wagonload trains** |
|---|---|---|---|
| **Up to 350km** | | | |
| **350 – 700km** | | | |
| **above 700km** | | | |

6. *What are the respective average transport costs (Euro per tonne kilometre?)*

| | **Block trains** | **Combined transport** | **Wagonload trains** |
|---|---|---|---|
| **Up to 350km** | | | |
| **350 – 700km** | | | |
| **above 700km** | | | |

7. *What are the buffer times that you plan for your transports? Are there any standard times depending on distance, type of goods, train segment? Please indicate buffer times according to the relevant criteria.*

| | |
|---|---|
| Distance | |
| Type of cargo | |
| Train segment | |
| Border crossings | |
| Origin characteristics (e.g. Terminal) | |
| Destination characteristics (e.g. Terminal) | |
| Others: *please specify* | |
| | |

| | |
|---|---|
| | |
| | |
| | |
| | |

## Modal Change

1. *In your opinion, from what distance is transport by railway more efficient than road transport?*

| Segment | Distance |
|---|---|
| Block trains | |
| Combined Transport | |
| Wagonload Trains | |

2. *In your opinion, how would your costumers react to a* ***price increase*** *of railway transport in the respective segment? Please estimate the modal shift as a percentage and provide the alternative mode.*

*Block trains:*

| Price increase | Long | Medium | Short |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |

| | | | |
|---|---|---|---|
| **15%** | | | |
| **20%** | | | |
| **30%** | | | |

*Wagonload Trains*

| Price increase | Long | Medium | Short |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |
| **30%** | | | |

*Combined Transport:*

| Price increase | Long | Medium | Short |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |

| | | | |
|---|---|---|---|
| **20%** | | | |
| **30%** | | | |

______________________________________________________________

______________________________________________________________

______________________________________________________________

3. In your opinion, how would your costumers react to an increase of transport times of railway transport in the respective segment? Please estimate the modal shift as a percentage and provide the alternative mode.

*Block trains:*

| **Transport time increase** | **Long** | **Medium** | **Short** |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |
| **30%** | | | |

*Wagonload Trains*

| Transport time increase | Long | Medium | Short |
|---|---|---|---|
| 1% | | | |
| 2% | | | |
| 5% | | | |
| 10% | | | |
| 15% | | | |
| 20% | | | |
| 30% | | | |

*Combined Transport:*

| Transport time increase | Long | Medium | Short |
|---|---|---|---|
| 1% | | | |
| 2% | | | |
| 5% | | | |
| 10% | | | |
| 15% | | | |
| 20% | | | |
| 30% | | | |

4. *How quickly could your customers switch their mode of transport?*

5. *How did **price** increases in the past affect your customers' modal choice? Please specify the past price increase and by how much traffic shifted. Was there any difference between long-term and short-term effects?*

6. *How did **transport time** increases in the past affect your customers' modal choice? Please specify the past transport time increase and by how much traffic shifted. Was there any difference between long-term and short-term effects?*

7. *In your opinion, are there any other reasons why customers change modes of transport besides price and transport times? Please specify.*

## Rolling Stock & Capacities

1. *What kind of rolling stock does your company currently operate? Please provide number, type and usage.*

| **Locomotives** | Numbers | Avg. operating hours per day |
|---|---|---|
| Diesel | | |
| Electric | | |
| **Wagons** | Numbers | Avg. operating hours per day |
| Container wagons | | |
| Dry bulk | | |
| Liquid bulk | | |
| General cargo | | |
| Other: *please specify* | | |
| | | |
| | | |
| | | |
| | | |

2. *Is your company the owner or is the equipment leased? Please specify.*

__________________________________________________________

__________________________________________________________

3. *Is there enough track capacity available in the Dutch railway network or has the capacity limit been reached in your opinion? Were there any (returning) issues in the past?*

4. *What percentage of your transports take place at night between 23h and 7h?*

| Segment | % of nightly trains |
|---|---|
| Block trains | |
| Combined Transport | |
| Wagonload Trains | |

5. *Are there any **planned** waiting times in your transports? What causes them? How long are these?*

______________________________________________________________________

______________________________________________________________________

6. *Are there any* ***unplanned*** *waiting times in your transports? What causes them? How long are these?*

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

## Outlook

1. *In the past, railway freight traffic has grown slower than overall freight transport, resulting in a slight loss of modal share. How do you estimate the demand development for railway transport until 2040 to be? Do you have annual growth rates to plan with?*

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

2. *What improvements or changes (both operationally and in terms of infrastructure) do you wish for the future in order to make railway transport to be more competitive versus other modes?*

________________________________________

________________________________________

________________________________________

________________________________________

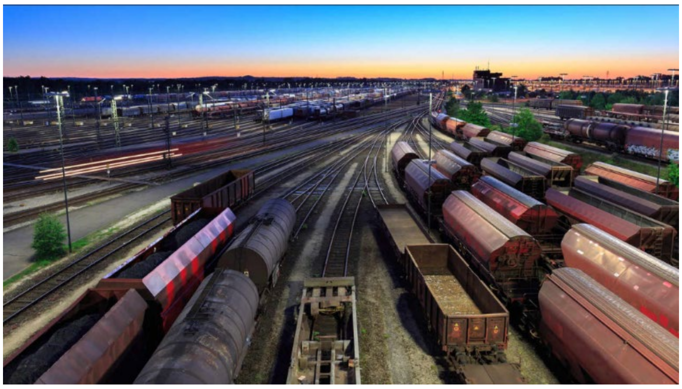
**Thank you very much for your time!**

Christopher Bingel
Railistics GmbH
Bahnhofstr. 36
65185 Wiesbaden

Tel.: 0611 44 7 88 28
Fax.: 0611 44 7 88 29
E-Mail: c.bingel@railistics.de

Appendix 3.2: Forwarders

# Questionnaire: Differentiated Driving – Introduction of a Speed Limit for Freight Trains



*Name:* ________________________________

*Position/Function:* ________________________________

*Company:* ________________________________

*Phone:* ________________________________

*Date:* ________________________________

*Signature:* ________________________________

**Privacy policy disclaimer:**

All Data will be treated as strictly confidential and will be only used for the purpose of this study. The purpose of the study is the preparation of a master's thesis by Christopher Bingel, University of Stellenbosch, in cooperation with Railistics GmbH, Wiesbaden. With the signature above I agree to the use of the data provided in the scope of the study.

## Modal Choice

8. *Which types of goods does your company mainly transport? Please estimate your company's transport volumes (per year) by type (if possible in absolute numbers, e.g. in tonne kilometres, otherwise as a percentage)*

| | |
|---|---|
| Dry bulk (coal, ore, sand, timber, waste, grain…) | |
| Liquid bulk (oil, petroleum, gas, chemicals,…) | |
| Containerized goods / intermodal | |
| Break bulk (e.g. machinery, steel collies, timber) | |
| Others: *please specify* | |

9. *From what type of industry do your customers come? Please estimate your company's transport volumes by industry (if possible in absolute numbers, e.g. in tonne kilometres, otherwise as a percentage)*

| | |
|---|---|
| Container Forwarders | |
| Chemical industry | |
| Automotive | |
| Agricultural | |
| Petroleum | |
| Mining / steel industry | |
| Others: *please specify* | |
| | |
| | |

| | |
|---|---|
| | |
| | |
| | |

10. *Which mode do you use to transport the goods and what is the different modes' respective share?*
*If you do not know the exact tonne kilometres, please estimate the respective percentages.*

| | Mode | Transport capacity in tonne-kilometres |
|---|---|---|
| ☐ | Road Transport | |
| ☐ | Rail Transport | |
| ☐ | Inland Waterways | |

11. *Why do you select the modes as indicated above? Please prioritize your criteria.*

| | Criteria | Priority |
|---|---|---|
| ☐ | Transport costs | |
| ☐ | Transport times | |
| ☐ | Reliability | |
| ☐ | Availability | |
| ☐ | Environment | |
| ☐ | Company expertise | |

| | | |
|---|---|---|
| ☐ | Safety | |
| ☐ | Others: | |
| | | |
| | | |
| | | |

12. *Which train type do you choose for transporting your goods and what is the respective annual share of these modes?*

*If you do not know the exact tonne kilometres, please estimate the respective percentages.*

| | **segment** | **volume in tonne kilometres** |
|---|---|---|
| ☐ | Block trains | |
| ☐ | Combined Transport | |
| ☐ | Wagonload Trains | |

13. *What are your most important origin-destination relations and their respective volumes per annum?*

| **Origin** | **Destination** | **volume in tonne kilometres** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

| | | |
|---|---|---|
| | | |
| | | |

14. *What are typical distances for the different segments? Please indicate what percentage the different distances account for in the respective train segment.*

*Each segment (block, combined, wagonload) should be seen separately and add up to 100%*

| | **Block trains** | **Combined transport** | **Wagonload trains** | **Trucks** | **Barges** |
|---|---|---|---|---|---|
| **Up to 350km** | | | | | |
| **350 – 700km** | | | | | |
| **above 700km** | | | | | |

15. *What are the respective average transport costs (Euro per tonne kilometre?)*

| | **Block trains** | **Combined transport** | **Wagonload trains** | **Trucks** | **Barges** |
|---|---|---|---|---|---|
| **Up to 350km** | | | | | |
| **350 – 700km** | | | | | |
| **above 700km** | | | | | |

16. *What are the buffer times that you plan for your transports? Are there any standard times depending on distance, type of goods, train segment? Please indicate buffer times according to the relevant criteria.*

| | |
|---|---|
| Distance | |

| | |
|---|---|
| Type of cargo | |
| Train segment | |
| Border crossings | |
| Origin characteristics (e.g. Terminal) | |
| Destination characteristics (e.g. Terminal) | |
| Others: *please specify* | |
| | |
| | |
| | |
| | |
| | |

## Modal Change

8. *In your opinion, from what distance is transport by railway more efficient that road transport?*

| Segment | Distance |
|---|---|
| Block trains | |
| Combined Transport | |
| Wagonload Trains | |

9. *In your opinion, how would your costumers react to a **price increase** of railway transport in the respective segment? Please estimate the modal shift as a percentage and provide the alternative mode.*

*Block trains:*

| Price increase | Long | Medium | Short |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |

| | | | |
|---|---|---|---|
| **20%** | | | |
| **30%** | | | |

*Wagonload Trains*

| **Price increase** | **Long** | **Medium** | **Short** |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |
| **30%** | | | |

*Combined Transport:*

| **Price increase** | **Long** | **Medium** | **Short** |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |

| | | | |
|---|---|---|---|
| **20%** | | | |
| **30%** | | | |

10. In your opinion, how would your costumers react to an increase of transport times of railway transport in the respective segment? Please estimate the modal shift as a percentage and provide the alternative mode.

*Block trains:*

| **Transport time increase** | **Long** | **Medium** | **Short** |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |
| **30%** | | | |

*Wagonload Trains*

| Transport time increase | Long | Medium | Short |
|---|---|---|---|
| 1% | | | |
| 2% | | | |
| 5% | | | |
| 10% | | | |
| 15% | | | |
| 20% | | | |
| 30% | | | |

*Combined Transport:*

| Transport time increase | Long | Medium | Short |
|---|---|---|---|
| 1% | | | |
| 2% | | | |
| 5% | | | |
| 10% | | | |
| 15% | | | |
| 20% | | | |
| 30% | | | |

11. *How quickly could your customers switch their mode of transport?*

12. *How did **price** increases in the past affect your customers' modal choice? Please specify the past price increase and by how much traffic shifted. Was there any difference between long-term and short-term effects?*

13. *How did **transport time** increases in the past affect your customers' modal choice? Please specify the past transport time increase and by how much traffic shifted. Was there any difference between long-term and short-term effects?*

*14. In your opinion, are there any other reasons why customers change modes of transport besides price and transport times? Please specify.*

## Rolling Stock & Capacities

1. *What kind of rolling stock does your company currently operate? Please provide number, type and usage.*

| **Locomotives** | Numbers | Avg. operating hours per day |
|---|---|---|
| Diesel | | |
| Electric | | |
| **Wagons** | Numbers | Avg. operating hours per day |
| Container wagons | | |
| Dry bulk | | |
| Liquid bulk | | |
| General cargo | | |
| Other: *please specify* | | |
| | | |
| | | |
| | | |
| | | |

2. *Is your company the owner or is the equipment leased? Please specify.*

____________________________________________________________

____________________________________________________________

____________________________________________________________

3. *Is there enough track capacity available in the Dutch railway network or has the capacity limit been reached in your opinion? Were there any (returning) issues in the past?*

5. *What percentage of your transports take place at night between 23h and 7h?*

| **Segment** | **% of nightly trains** |
|---|---|
| Block trains | |
| Combined Transport | |
| Wagonload Trains | |

5. *Are there any* ***planned*** *waiting times in your transports? What causes them? How long are these?*

7. *Are there any **unplanned** waiting times in your transports? What causes them? How long are these?*

## Outlook

1. *In the past, railway freight traffic has grown slower than overall freight transport, resulting in a slight loss of modal share. How do you estimate the demand development for railway transport until 2040 to be? Do you have annual growth rates to plan with?*

2. *What improvements or changes (both operationally and in terms of infrastructure) do you wish for the future in order to make railway transport to be more competitive versus other modes?*

Appendix 3.3: Consignors

# Differentiated Driving – Introduction of a Speed Limit for Freight Trains

*Name:* ______________________________

*Position/Function:* ______________________________

*Company:* ______________________________

*Phone:* ______________________________

*Date:* ______________________________

*Signature:* ______________________________

**Privacy policy disclaimer:**

All Data will be treated as strictly confidential and will be only used for the purpose of this study. The purpose of the study is the preparation of a master's thesis by Christopher Bingel, University of Stellenbosch, in cooperation with Railistics GmbH, Wiesbaden. With the signature above I agree to the use of the data provided in the scope of the study.

## Company Profile

1. *In which industry is your company engaged?*

| | |
|---|---|
| Chemical industry | |
| Automotive | |
| Agricultural | |
| Petroleum | |
| Mining / steel industry | |
| Others: *please specify* | |
| | |
| | |
| | |
| | |
| | |

2. *How long has the company been active in rail transportation?*

____________________________________________________________

____________________________________________________________

3. *Which types of goods does your company mainly receive (inbound)? Please estimate your company's transport volumes (per year) by type (if possible in absolute numbers, e.g. in tonne kilometres, otherwise as a percentage)*

| | |
|---|---|
| Dry bulk (coal, ore, sand, timber, waste, grain…) | |
| Liquid bulk (oil, petroleum, gas, chemicals,…) | |
| Containerized goods / intermodal | |
| Break bulk (e.g. machinery, steel collies, timber) | |
| Others: *please specify* | |

4. *Which types of goods does your company mainly ship (outbound)? Please estimate your company's transport volumes (per year) by type (if possible in absolute numbers, e.g. in tonne kilometres, otherwise as a percentage)*

| | |
|---|---|
| Dry bulk (coal, ore, sand, timber, waste, grain…) | |
| Liquid bulk (oil, petroleum, gas, chemicals,…) | |
| Containerized goods / intermodal | |
| Break bulk (e.g. machinery, steel collies, timber) | |
| Others: *please specify* | |

# Modal Choice

1. *Which mode do you choose for transporting your goods and what is the respective share of these modes?*
*If you do not know the exact tonne kilometres, please estimate the respective percentages.*

| | **Mode** | **Tonne kilometres** |
|---|---|---|
| ☐ | Truck / Road transport | |
| ☐ | Railway | |
| ☐ | Inland waterway | |

2. *Why do you select the modes as indicated above? Please prioritize your criteria*

| | **Criteria** | **Priority** |
|---|---|---|
| ☐ | Transport costs | |
| ☐ | Transport times | |
| ☐ | Reliability | |
| ☐ | Availability | |
| ☐ | Environment | |
| ☐ | Company expertise | |
| ☐ | Safety | |
| ☐ | Others: | |

| | | |
|---|---|---|
| | | |
| | | |
| | | |

3. *Which train type do you choose for transporting your goods and what is the respective annual share of these modes?*

*Multiple selection is possible. Please indicate the purpose and share per mode if your company makes use of multiple options.*

| | **Freight train type** | **Tonne kilometres** |
|---|---|---|
| ☐ | Block trains | |
| ☐ | Combined transport | |
| ☐ | Wagonload trains | |

4. *What are your most important origin-destination pairs and the respective amounts transported per annum?*

| **Origin** | **Destination** | **volume in tonne kilometres** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

| | | |
|---|---|---|
| | | |

5. *What are the preferred modes depending on the transport distance?*

| | **Block trains** | **Combined transport** | **Wagonload trains** | **Truck** | **Inland waterway** |
|---|---|---|---|---|---|
| **Up to 350km** | | | | | |
| **350 – 700km** | | | | | |
| **above 700km** | | | | | |

6. *What are the estimated transport costs (Euro per tonne kilometres)?*

| | **Block trains** | **Combined transport** | **Wagonload trains** | **Truck** | **Inland waterway** |
|---|---|---|---|---|---|
| **Up to 350km** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **350 – 700km** | | | | | |
| **above 700km** | | | | | |

7. *What are the buffer times that you plan for your transports? Are there any standard times depending on distance, type of goods, train segment? Please indicate buffer times according to the relevant criteria.*

| | |
|---|---|
| Distance | |
| Type of cargo | |
| Train segment | |
| Border crossings | |
| Origin characteristics (e.g. Terminal) | |
| Destination characteristics (e.g. Terminal) | |
| Others: *please specify* | |
| | |
| | |
| | |
| | |
| | |

# Modal Change

1. *In your opinion, from what distance is the use of railway more economic than road transport?*

| Segment | Distance |
|---|---|
| Block trains | |
| Combined Transport | |
| Wagonload Trains | |

2. *How would you react to an **increase of transport prices** for railway freight in the respective segment? Please estimate the percentage change towards other modes. Feel free to make use of the free-text section for any explanation.*

*Block trains:*

| Price increase | Long | Medium | Short |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |

| | | | |
|---|---|---|---|
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |
| **30%** | | | |

*Wagonload Trains*

| **Price increase** | **Long** | **Medium** | **Short** |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |
| **30%** | | | |

*Combined Transport:*

| **Price increase** | **Long** | **Medium** | **Short** |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |

| | | | |
|---|---|---|---|
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |
| **30%** | | | |

3. *How would you react to an **increase of transport times** for railway freight in the respective segment? Please estimate the percentage change towards other modes. Feel free to make use of the free-text section for any explanation.*

*Block trains:*

| Transport time increase | Long | Medium | Short |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |

| | | | |
|---|---|---|---|
| **15%** | | | |
| **20%** | | | |

*Wagonload Trains*

| **Transport time increase** | **Long** | **Medium** | **Short** |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |

*Combined Transport:*

| **Transport time increase** | **Long** | **Medium** | **Short** |
|---|---|---|---|
| **1%** | | | |
| **2%** | | | |
| **5%** | | | |

| | | | |
|---|---|---|---|
| **10%** | | | |
| **15%** | | | |
| **20%** | | | |

4. *How did **price increases** in railway freight impact on your modal choice in the past? Please specify the past price increase and by how much traffic shifted. Was there any difference between long-term and short-term effects?*

5. *How did **transport time increases** in railway freight impact on your modal choice in the past? Please specify the past transportation time increase and by how much traffic shifted. Was there any difference between long-term and short-term effects?*

6. *How quickly could you switch the mode of transport?*

7. *Are there any other reasons why a change of transport mode besides price and transport times could be interesting for you? Please specify.*

## Rolling Stock

1. *Does your company own rolling stock? If so, please specify type and quantity.*

| **Locomotives** | Numbers | Avg. operating hours per day |
|---|---|---|
| Diesel | | |
| Electric | | |
| **Wagons** | Numbers | Avg. operating hours per day |
| Container wagons | | |
| Dry bulk | | |
| Liquid bulk | | |
| General cargo | | |
| Other: *please specify* | | |
| | | |
| | | |
| | | |
| | | |

2. *Is this rolling stock owned or leased? If partially, please specify as precisely as possible.*

______________________________________________

______________________________________________

3. *Is there enough track capacity available in the Dutch railway network or has the capacity limit been reached in your opinion? Were there any (returning) issues in the past?*

____________________________________________________________________________

____________________________________________________________________________

____________________________________________________________________________

____________________________________________________________________________

4. *What percentage of your transports take place at night between 23h and 7h?*

| **Segment** | **% of nightly trains** |
|---|---|
| Block trains | |
| Combined Transport | |
| Wagonload Trains | |

5. *Are there any **planned** waiting times in your transports? What causes them? How long are these?*

____________________________________________________________________________

____________________________________________________________________________

6. *Are there any* ***unplanned*** *waiting times in your transports? What causes them? How long are these?*

## Future Outlook

1. *In the past, railway freight traffic has grown slower than overall freight transport, resulting in a slight loss of modal share. How do you estimate your own demand development for railway transport until 2040 to be? Do you have annual growth rates to plan with?*

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

2. *What improvements or changes (both operationally and in terms of infrastructure) do you wish for the future in order to make railway transport to be more competitive versus other modes?*

______________________________________________

______________________________________________

______________________________________________

______________________________________________

# Appendix 4: Schedules used for the Schedule Analysis

Dienstregeling goederentreinen — Disclaimer: zie onderaan — © : Rolandrail.net

Stand: 01-01-19 (versie2019a)

CROSSRAIL

| Treinnr | Dagen* | Tijden | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40101 | ma-vr | Esn | 18.46 | Rsd | 18.58/19.06 | Bd | 19.28 | Tb | 19.47 | Ehv | 20.13 | Vl | 20.52/22.28 | Antwerpen-Gallarate | Containers |
| 41567 | ma-vr | Esn | 18.33 | Rsd | 18.46 | Bd | 19.12 | Tb | 19.29 | Ehv | 20.00 | Vl | 20.45/20.58 | Antwerpen-Neuss | Containers |
| 42506 | ma | Vl | 22.51/23.32 | Ehv | 00.12 | Tb | 00.39 | Bd | 00.56 | Rsd | 01.16 | Esn | 01.26 | Germersheim-Antwerpen | Containers |
| | wo | Vl | 04.42/05.07 | Ehv | 05.47 | Tb | 06.13 | Bd | 06.29/06.56 | Rsd | 07.19 | Esn | 07.27 | | |
| 42533 | za | Esn | 17.51 | Rsd | 18.03/18.06 | Bd | 18.28 | Tb | 18.47 | Ehv | 19.13 | Vl | 19.50/19.58 | Antwerpen-Bonn | Containers |
| 44560 | di-za | Vl | 05.52/06.22 | Ehv | 07.02 | Tb | 07.32 | Bd | 07.49 | Rsd | 08.11/08.42 | Esn | 08.54 | Neuss-Antwerpen | Containers |

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Stand: 01-01-19 (versie2019a)

CAPTRAIN

| Treinnr | Dagen* | Tijden | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40026 | wo | Vl | 09.32/09.37 | Ehv | 10.17 | Ht | 10.41 | Gdm | 10.59/11.02 | Asd | 12.02 | Hrp | 12.15 | Melzo | Containers |
| 40027 | do | Hrp | 10.17 | Asd | 10.28 | Gdm | 11.25/11.29 | Ht | 11.49 | Ehv | 12.10 | Vl | 12.51/13.08 | Melzo | Containers |
| 40028 | za | Vl | 09.24/09.37 | Ehv | 10.17 | Ht | 10.41 | Gdm | 10.59/11.02 | Asd | 12.02 | Hrp | 12.15 | Melzo | Containers |
| 40029 | ma | Whz | 06.50 | Kfhn | 07.05/08.30 | Bd | 09.02 | Ehv | 09.43 | Vl | 10.21/10.30 | Kn | 10.39 | Melzo | Containers |
| 40126 | ma-vr | Kn | 23.02 | Vl | 23.11/23.20 | Ehv | 00.02 | Bd | 00.53 | Kfhn | 01.28/01.44 | Whz | 01.57 | Melzo | Containers |
| 40127 | ma | Hrp | 19.17 | Asd | 19.28 | Gdm | 20.22/20.29 | Ht | 20.48 | Ehv | 21.13 | Vl | 21.51/21.58 | Melzo | Containers |
| | di-vr | Whz | 19.16 | Kfhn | 19.29/19.38 | Bd | 20.12 | Ehv | 21.00 | Vl | 21.46/22.13 | Kn | 22.22 | | |
| 40128 | zo | Kn | 13.02 | Vl | 13.11/13.37 | Ehv | 14.17 | Bd | 14.59 | Kfhz | 15.25 | Whz | 15.39 | Melzo | Containers |
| 40129 | za | Whz | 17.20 | Kfhn | 17.35/17.38 | Bd | 18.12 | Ehv | 19.00 | Vl | 19.43/19.48 | Kn | 19.55 | Melzo | Containers |
| 40130 | ma | Em | 05.29 | Brvalo | 05.56 | Brmet | 06.24 | Gdm | 06.29/06.37 | Asd | 07.32 | Hrp | 07.46 | Melzo | Containers |
| 40131 | zo | Hrp | 15.17 | Asd | 15.28 | Gdm | 16.26/16.29 | Ht | 16.49 | Ehv | 17.13 | Vl | 17.51/18.08 | Melzo | Containers |
| 41524 | ma-do | Kn | 20.15 | Vl | 20.24/20.36 | Ehv | 21.17 | Tb | 21.44 | Rsd | 22.16/22.26 | Esn | 22.36 | Mülheim-Atw-Valenciennes | Staal |
| 41525 | ma,di,do,vr | Esn | 07.01 | Rsd | 07.13/07.15 | Tb | 07.59 | Ehv | 08.30 | Vl | 09.15/09.18 | Kn | 09.28 | Mülheim-Atw-Valenciennes | Staal |
| | wo | Esn | 07.02 | Rsd | 07.13/07.15 | Kfh | 07.55/09.11 | Brmet | 09.52 | Brvalo | 10.19 | Em | 10.44 | | |
| 41526 | zo | Em | 13.15 | Brvalo | 13.46 | Brmet | 14.13 | Kfh | 14.53/17.00 | Rsd | 17.39 | Esn | 17.48 | Mülheim-Atw-Valenciennes | Staal |
| 41720 | di | Vl | 07.11/07.37 | Ehv | 08.17 | Tb | 08.44 | Bd | 08.59 | Kfhn | 09.27/09.41 | Mvtw | 10.25 | Strasbourg/Kehl | Containers |
| 41721 | zo | Mvtw | 16.35 | Kfhn | 17.19/17.30 | Bd | 18.02 | Tb | 18.17 | Ehv | 18.43 | Vl | 19.20/19.50 | Strasbourg/Kehl | Containers |
| 41728 | vr | Vl | 08.23/08.51 | Ehv | 09.32 | Tb | 10.02 | Bd | 10.18 | Kfhn | 10.52/10.54 | Mvtw | 11.38 | Strasbourg/Kehl | Containers |
| 41739 | za | Whz | 18.35 | Kfhn | 18.47/18.56 | Brgnd | 19.10 | Brmet | 19.32 | Brvalo | 19.58 | Em | 20.25 | Ludwigshafen | Containers |
| 41740 | zo | Em | 08.19 | Brvalo | 08.46 | Brmet | 09.13 | Brgnd | 09.35 | Kfhn | 09.53/12.26 | Whz | 12.41 | Ludwigshafen | Containers |
| 41748 | di-za | Em | 02.59 | Brvalo | 03.26 | Brmet | 03.53 | Brgnd | 04.14 | Kfhn | 04.32/04.35 | Whz | 04.49 | Ludwigshafen | Containers* |
| 41749 | ma-vr | Whz | 21.22 | Kfhn | 21.34/21.43 | Brgnd | 22.00 | Brmet | 22.22 | Brvalo | 22.48 | Em | 23.15 | Ludwigshafen | Containers |
| 41771 | wo | Mvtw | 16.35 | Kfhn | 17.19/17.30 | Bd | 18.02 | Tb | 18.17 | Ehv | 18.43 | Vl | 19.20/19.50 | Strasbourg/Kehl | Containers |
| 43651 | za | Lutdsm | 16.18 | Std | 16.27 | Rm | 16.45 | Vl | 17.14/18.00 | Kn | 18.07 | | | Gallarate | Containers |
| 43652 | zo | Kn | 07.10 | Vl | 07.19/08.15 | Rm | 08.45 | Std | 09.07 | Lutdsm | 09.13 | | | Gallarate | Containers |
| 43656 | di | Kn | 03.34 | Vl | 03.43/04.45 | Rm | 05.09 | Std | 05.30/06.01 | Lutdsm | 06.08 | | | Gallarate | Containers |
| 43657 | ma-do | Lutdsm | 22.19 | Std | 22.26 | Rm | 22.45 | Vl | 23.14/00.44 | Kn | 00.53 | | | Gallarate | Containers |
| 43658 | wo | Kn | 00.40 | Vl | 00.49/04.50 | Rm | 05.13 | Std | 05.37/06.10 | Lutdsm | 06.17 | | | Gallarate | Containers |
| | do | Kn | 00.30 | Vl | 00.39/02.08 | Rm | 02.09 | Std | 02.30/06.10 | Lutdsm | 06.17 | | | Gallarate | Containers |
| | vr | Kn | 00.30 | Vl | 00.39/01.45 | Rm | 02.32 | Std | 02.53/06.10 | Lutdsm | 06.17 | | | Gallarate | Containers |
| | za | Kn | 00.30 | Vl | 00.39/02.00 | Rm | 02.24 | Std | 02.45/06.10 | Lutdsm | 06.17 | | | Gallarate | Containers |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43659 | zo | Lutdsm | 19.02 | Std | 19.10/19.26 | Rm | 19.45 | Vl | 20.15/21.08 | Kn | 21.17 | | | Gallarate | Containers |
| 43660 | zo | Kn | 06.53 | Vl | 07.02/07.45 | Rm | 08.15 | Std | 08.37/08.40 | Lutdsm | 08.48 | | | Gallarate | Containers |
| 43710 | ma,di,do,vr | Kn | 06.23 | Vl | 06.32/08.15 | Rm | 08.45 | Std | 09.07 | Lutdsm | 09.17 | | | Gallarate | Containers, ing. 01-04 |
| 43713 | ma,di,do,vr | Lutdsm | 16.18 | Std | 16.27 | Rm | 16.45 | Vl | 17.14/18.00 | Kn | 18.07 | | | Gallarate | Containers, ing. 01-04 |
| 47622 | ma | Fvs | 06.32 | Mt | 06.45 | Std | 07.07/07.30 | Bon | 07.50 | | | | | Anglefort/Woippy | Leeg kolen+ketelwagens |
| | di-vr | Fvs | 04.32 | Mt | 04.46 | Std | 05.07/07.00 | Bon | 07.20 | | | | | | #za FM llt Std-Bon |
| | za# | Fvs | 08.02 | Mt | 08.15 | Std | 08.38/08.50 | Bon | 09.10 | | | | | | |
| 47623 | ma-vr | Bon | 13.30 | Std | 13.45/16.48 | Mt | 17.16 | Fvs | 17.31 | | | | | Woippy/Anglefort | Kolen+ktlwgns, vr Bon-Std FM llt |
| | za | Bon | 09.54 | Std | 10.15/10.20 | Mt | 10.46 | Fvs | 11.01 | | | | | | FM |
| 47770 | ma-vr | Em | 13.09 | Brvalo | 13.36 | Brmet | 14.03 | Brgnd | 14.24 | Kfhn | 14.42/14.50 | Mvt | 15.36 | Bottrop | Leeg kolen, tot 01-04 |
| 47771 | ma-vr | Mvt | 06.15 | Kfhn | 06.59/07.04 | Brgnd | 07.21 | Brmet | 07.45 | Brvalo | 08.16 | Em | 08.45 | Bottrop | Kolen, tot 01-04 |
| 47772 | ma-vr | Em | 01.49 | Brvalo | 02.16 | Brmet | 02.43 | Brgnd | 03.04 | Kfhn | 03.22/03.40 | Mvt | 04.25 | Bottrop | Leeg kolen, tot 01-04 |
| 47773 | ma-vr | Mvt | 18.25 | Kfhn | 19.09/19.11 | Brgnd | 19.30 | Brmet | 19.52 | Brvalo | 20.18 | Em | 20.45 | Bottrop | Kolen, tot 01-04 |
| 49506 | di-vr | Em | 07.09 | Brvalo | 07.36 | Brmet | 08.03 | Brgnd | 08.24 | Kfhn | 08.43/08.46 | Mvt | 09.32 | Bottrop | Leeg kolen, ing. 01-04 |
| 49507 | di-vr | Mvt | 18.25 | Kfhn | 19.09/19.11 | Brgnd | 19.30 | Brmet | 19.52 | Brvalo | 20.18 | Em | 20.45 | Bottrop | Kolen, ing. 01-04 |
| 49509 | zo | Mvt | 18.35 | Kfhn | 19.19/19.23 | Brgnd | 19.40 | Brmet | 20.02 | Brvalo | 20.28 | Em | 20.55 | Bottrop | Kolen, ing. 01-04 |
| 49526 | za | Em | 12.09 | Brvalo | 12.36 | Brmet | 13.03 | Brgnd | 13.24 | Kfhn | 13.42/13.56 | Mvt | 14.42 | Bottrop | Leeg kolen, ing. 01-04 |
| 49527 | ma | Mvt | 08.55 | Kfhz | 09.40 | Brgnd | 09.54 | Brmet | 10.18 | Brvalo | 10.47 | Em | 11.15 | Bottrop | Kolen, ing. 01-04 |
| 51012 | di,wo,za | Kfh | 01.33 | Whz | 01.48 | | | | | | | | | | UC i.o.v. LNA |
| | do,vr | Kfh | 01.49 | Whz | 02.03 | | | | | | | | | | |
| 51013 | di-za | Whz | 04.00 | Kfh | 04.18 | | | | | | | | | | UC i.o.v. LNA |
| 51016 | di-vr | Zlw | 23.59 | Mdk | 00.51 | | | | | | | | | Milano Segrate | Containers i.o.v. LNA |
| 51017 | ma-do | Mdk | 22.20 | Zlw | 22.45 | | | | | | | | | Milano Segrate | Containers i.o.v. LNA |
| 51018 | zo | Zlw | 12.30 | Mdk | 12.55 | | | | | | | | | Milano Segrate | Containers i.o.v. LNA |
| 51019 | vr | Mdk | 23.26 | Zlw | 23.51 | | | | | | | | | Milano Segrate | Containers i.o.v. LNA |
| 51050 | di,do,vr | Lutdsm | 16.04 | Std | 16.12/17.26 | Rm | 17.43 | Wt | 17.57 | Ohze | 18.07 | Ehv | 18.17 | | UBC/Den Hartogh-containers |
| | | Tb | 18.44 | Bd | 18.59 | Zlw | 19.12/20.00 | Mdk | 20.25 | | | | | | |
| 51051 | di | Zlw | 07.51 | Bd | 08.03 | Btl | 08.28 | Ehv | 08.43 | Wt | 09.05/09.32 | Rm | 09.51 | | UBC/Den Hartogh-containers |
| | | Std | 10.10/11.05 | Lutdsm | 11.15 | | | | | | | | | | |
| | wo | Mdk | 06.21 | Zlw | 06.46/07.51 | Bd | 08.02 | Btl | 08.28 | Ehv | 08.40 | Wt | 09.05/09.32 | | |
| | | Rm | 09.51 | Std | 10.10/11.05 | Lutdsm | 11.15 | | | | | | | | |
| | vr | Mdk | 06.21 | Zlw | 06.46/07.51 | Bd | 08.02 | Btl | 08.28 | Ehv | 08.40 | Wt | 09.04 | | |
| | | Mbt | 09.28/09.57 | Std | 10.10/11.05 | Lutdsm | 11.15 | | | | | | | | |
| 51052 | za | Mdk | 10.07* | Zlw | 10.35 | | | | | | | | | * In praktijk 's nachts | UBC/Den Hartogh-containers |
| 51055 | ma-vr | Sloe | 09.38 | Gs | 10.01 | Bgn | 10.27 | Rsd | 10.39 | Bd | 11.02 | Tb | 11.17 | | LPG; di,do FZ |
| | | Ehv | 11.43 | Wt | 12.04 | Rm | 12.21 | Std | 12.41/13.32 | Lutdsm | 13.45 | | | | |
| | za | Sloe | 08.05 | Gs | 08.28 | Bgn | 08.54 | Rsd | 09.06 | Bd | 09.28 | Tb | 09.47 | | FZ |
| | | Ehv | 10.10 | Wt | 10.34 | Rm | 10.51 | Std | 11.11/12.03 | Lutdsm | 12.17 | | | | |
| 51056 | ma-vr | Lutdsm | 11.00 | Std | 11.08/13.56 | Rm | 14.15 | Wt | 14.32/14.53 | Ehv | 15.17 | Tb | 15.44 | | Leeg LPG; di,do FZ |
| | | Bd | 15.59 | Rsd | 16.20 | Rb | 16.43 | Gs | 16.58 | Lwd | 17.10/17.28 | Sloe | 17.39 | | |
| | za | Lutdsm | 10.50 | Std | 10.58/12.56 | Rm | 13.15 | Wt | 13.32/13.52 | Ehv | 14.17 | Tb | 14.44 | | FZ |
| | | Bd | 14.59 | Rsd | 15.20 | Rb | 15.43 | Gs | 15.58 | Lwd | 16.10 | Sloe | 16.21 | | |
| 51062 | ma,vr | Kfh | 07.03 | Zlw | 07.25 | Otw | 07.56 | | | | | | | | FM Gefco |
| 51063 | ma,vr | Otw | 16.55 | Zlw | 17.30/17.34 | Kfh | 17.56 | | | | | | | | FM Leeg Gefco |
| 51066 | di,di,za | Kfh | 07.07 | Zlw | 07.26 | Rsd | 07.46 | | | | | | | Zeebrugge | Gefco |
| 51067 | di,do,vr | Rsd | 15.16 | Zlw | 15.34 | Kfh | 15.55 | | | | | | | Zeebrugge | Gefco |
| 51068 | ma,wo,vr | Kfh | 07.10 | Zlw | 07.30 | Rsd | 07.48 | | | | | | | Zeebrugge | Gefco |
| 51069 | ma,wo,za | Rsd | 15.16 | Zlw | 15.34 | Kfh | 15.55 | | | | | | | Zeebrugge | Gefco |
| 51622 | di-vr | Std | 05.50 | Lutdsm | 05.58 | | | | | | | | | | Ketelwagens 47622 |
| | za | Std | 09.50 | Lutdsm | 09.58 | | | | | | | | | | |
| 51623 | ma-vr | Lutdsm | 15.34 | Std | 15.40 | | | | | | | | | | Ketelwagens 47623 |

* Rijdt niet van week 29 t/m week 34

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Stand: 01-01-19 (versie2019a)

LINEAS

| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40650 | wo,vr | Vl | 15.23/15.37 | Ehv | 16.17 | Tb | 16.44 | Bd | 16.59 | Rsd | 17.20/17.43 | Esn | 17.53 | Passau-Antwerpen | |
| | zo | Vl | 15.23/15.51 | Ehv | 16.32 | Tb | 17.02 | Bd | 17.19 | Rsd | 17.38/17.43 | Esn | 17.53 | | |
| 40950 | di,do-za | Bh | 17.56 | Aml | 18.39 | Dv | 19.07 | Apd | 19.20 | Amf | 19.52/21.14 | Gdm | 21.52/21.59 | Ústí nad Labem-Antwerpen | GXN Czech-Xpress, UC |
| | | Tb | 22.35 | Rsd | 23.10/23.17 | Esn | 23.27 | | | | | | | | |
| | wo | Bh | 17.56 | Aml | 18.39 | Dv | 19.07 | Apd | 19.20 | Amf | 19.52/20.44 | Gdm | 21.23/21.29 | | |
| | | Tb | 22.04 | Rsd | 22.42/23.17 | Esn | 23.27 | | | | | | | | |
| | zo | Bh | 17.56 | Aml | 18.39 | Dv | 19.07 | Apd | 19.20 | Amf | 19.52/20.14 | Gdm | 20.55/21.00 | | |
| | | Tb | 21.35 | Rsd | 22.10/23.17 | Esn | 23.27 | | | | | | | | |
| 40951 | ma-za | Esn | 10.46 | Rsd | 10.57/11.06 | Bd | 11.28 | Tb | 11.47 | Ht | 12.11 | Gdm | 12.29/12.32 | Antwerpen-Ústí nad Labem | GXN Czech-Xpress, UC |
| | | Ut | 12.53 | Amf | 13.15 | Sto | 13.32/13.51 | Dv | 14.23 | Aml | 14.50 | Bh | 15.26 | | |
| 40952 | wo,vr | Em | 12.29 | Brvalo | 12.56 | Brmet | 13.23/14.06 | Tb | 14.42 | Rsd | 15.17 | Esn | 15.27 | Poznan-Antwerpen | GXN Poland-Xpress, UC |
| 40953 | di | Esn | 02.06 | Rsd | 02.17/02.46 | Tb | 03.27 | Nm | 04.27 | Ah | 04.45 | Em | 05.15 | Antwerpen-Poznan | GXN Poland-Xpress, UC |
| | do | Esn | 02.06 | Rsd | 02.17 | Kfh | 02.55/03.40 | Brmet | 04.19 | Brvalo | 04.48 | Em | 05.15 | | |
| | za | Esn | 02.46 | Rsd | 02.57 | Tb | 03.37 | Brmet | 04.20 | Brvalo | 04.48 | Em | 05.15 | | |
| 40954 | zo | Em | 16.29 | Brcup | 17.00/17.49 | Brmet | 18.18/18.36 | Tb | 19.12 | Rsd | 19.44 | Esn | 19.53 | Poznan-Antwerpen | GXN Poland-Xpress, UC |
| 41505 | ma-vr | Esn | 07.46 | Rsd | 07.57/08.06 | Tb | 08.47 | Brmet | 09.27/09.28 | Brvalo | 09.58 | Em | 10.25 | Antwerpen-Recklinghausen | FM |
| 41506 | ma-vr | Em | 16.19 | Brvalo | 16.45 | Mbtwaz | 17.14/17.31 | Tb | 18.04 | Rsd | 18.43 | Esn | 18.53 | Recklinghausen-Antwerpen | FM |
| 41518 | ma,di | Vl | 23.02/23.52 | Ehv | 00.38 | Tb | 01.05 | Bd | 01.24 | Rsd | 01.42/01.44 | Esn | 01.53 | Ludwigshafen-Antwerpen | GXN, UC |
| | wo-vr | Vl | 23.02/23.37 | Ehv | 00.17 | Tb | 00.43 | Bd | 00.58 | Rsd | 01.15/01.44 | Esn | 01.53 | | |
| 41532 | zo | Bh | 13.23 | Odz | 13.39/14.46 | Aml | 15.09 | Dv | 15.37 | Amf | 16.22/16.43 | Wp | 17.14 | Buna Werke-Antwerpen | GXN Saxonia Xpress, UC |
| | | Wd | 17.47 | Rtd | 18.15/18.33 | Kfhz | 18.52/19.03 | Rsd | 19.41/19.55 | Esn | 20.05 | | | | |
| 41552 | zo | Vl | 18.39/18.51 | Ehv | 19.32 | Tb | 20.02 | Bd | 20.18 | Rsd | 20.41 | Esn | 20.50 | Ruhland-Antwerpen | Containers |
| 41558 | di-za | Vl | 03.55/04.22 | Ehv | 05.05 | Tb | 05.34 | Bd | 05.51 | Rsd | 06.10/06.45 | Esn | 06.55 | Ruhland-Antwerpen | Containers |
| 41600 | ma-vr | Fsz | 09.37 | Svg | 09.47/09.50 | Slua | 10.11 | Sludow | 10.26 | | | | | Antwerpen Combinant | Containers |
| 41601 | ma-vr | Sludow | 17.56 | Slua | 18.11 | Svg | 18.32/18.35 | Fsz | 18.45 | | | | | Antwerpen Combinant | Containers |
| 41765 | wo | Lutdsm | 02.36 | Std | 02.43 | Rm | 03.05/03.08 | Vl | 03.32/04.23 | Kn | 04.31 | | | Dormagen | Ketelwagens |
| 41767 | ma,wo,vr | Lutdsm | 14.48 | Std | 14.55 | Rm | 15.15 | Vl | 15.44/17.15 | Kn | 17.24 | | | Marl | Ketelwagens |
| 41768 | di,do,za | Kn | 06.37 | Vl | 06.46/07.45 | Rm | 08.15 | Std | 08.38 | Lutdsm | 08.48 | | | Marl | Ketelwagens |
| 42516 | di-vr | Kn | 21.15 | Vl | 21.23/21.52 | Ehv | 22.32 | Tb | 23.02 | Bd | 23.18 | Zlw | 23.31 | Milano Smistamento | Containers ("Segrate-sh") |
| 42517 | ma-do | Zlw | 23.54 | Bd | 00.07 | Tb | 00.21 | Ehv | 00.46 | Vl | 01.24/01.37 | Kn | 01.45 | Milano Smistamento | Containers ("Segrate-sh") |
| 42518 | za | Kn | 19.54 | Vl | 20..02/20.07 | Ehv | 20.47 | Tb | 21.14 | Bd | 21.29 | Zlw | 21.41 | Milano Smistamento | Containers ("Segrate-sh") |
| 42519 | za | Zlw | 00.28 | Bd | 00.42 | Tb | 00.58 | Ehv | 01.24 | Vl | 02.02/02.08 | Kn | 02.16 | Milano Smistamento | Containers ("Segrate-sh") |
| 42520 | ma | Kn | 21.13 | Vl | 21.21/21.22 | Ehv | 22.02 | Tb | 22.32 | Bd | 22.48 | Zlw | 23.01 | Milano Smistamento | Containers ("Segrate-sh") |
| 42521 | zo | Zlw | 13.29 | Bd | 13.42 | Tb | 13.59 | Ehv | 14.30 | Vl | 15.15/15.28 | Kn | 15.36 | Milano Smistamento | Containers ("Segrate-sh") |
| 42557 | ma-vr | Esn | 12.46 | Rsd | 12.57/13.06 | Bd | 13.28 | Tb | 13.47 | Ht | 14.11 | Gdm | 14.29/14.32 | Antwerpen-Buna Werke | GXN Saxonia Xpress, UC |
| | | Ut | 14.53 | Amf | 15.15 | Sto | 15.33/15.51 | Dv | 16.23 | Aml | 16.50 | Bh | 17.24 | | |
| 42558 | di | Bh | 22.42 | Odz | 23.01/23.12 | Dvge | 00.08/00.56 | Ah | 01.48 | Ht | 02.38 | Rsd | 03.30/03.43 | Buna Werke-Antwerpen | GXN Saxonia Xpress, UC |
| | wo,do | Bh | 22.51 | Odz | 23.01/23.12 | Dv | 00.07 | Amf | 00.57/01.23 | Wd | 02.20 | Rtd | 02.55 | | |
| | | Rsd | 03.44 | Esn | 03.53 | | | | | | | | | | |
| | vr | Bh | 22.51 | Odz | 23.01/23.12 | Dv | 00.07 | Amf | 00.52 | Rtd | 02.26 | Esn | 03.28 | | |
| 42725 | wo,zo | Kfhn | 11.30 | Bd | 12.02 | Tb | 12.17 | Ehv | 12.43 | Vl | 13.21/14.36 | Kn | 14.47 | Maasvlakte-Trier | Containers ("Trier-shutlle") |
| 42970 | di,do,za | Vl | 15.23/15.37 | Ehv | 16.17 | Tb | 16.44 | Bd | 16.59 | Rsd | 17.20/17.43 | Esn | 17.53 | Wels-Antwerpen | Containers |
| 44556 | wo,vr | Em | 11.39 | Brcup | 12.10/12.39 | Brmet | 13.11 | Tb | 13.44 | Rsd | 14.26/14.42 | Esn | 14.53 | Grosskorbetha-Antwerpen | Ing. 04-02, GXN Saxonia Xpress, UC |
| 44558 | zo | Em | 17.59 | Brvalo | 18.26 | Brmet | 18.53/19.07 | Tb | 19.43 | Rsd | 20.16/20.43 | Esn | 20.53 | Grosskorbetha-Antwerpen | Ing. 04-02, GXN Saxonia Xpress, UC |
| 44559 | di | Esn | 03.46 | Rsd | 03.57/04.06 | Tb | 04.41 | Nm | 05.34 | Ah | 05.52 | Em | 06.25 | Antwerpen-Grosskorbetha | Ing. 04-02, GXN Saxonia Xpress, UC |
| | do | Esn | 03.46 | Rsd | 03.57 | Kfh | 04.35/04.51 | Brmet | 05.30 | Brvalo | 05.58 | Em | 06.25 | | |
| | za | Esn | 03.46 | Rsd | 03.57/04.05 | Tb | 04.47 | Brmet | 05.30 | Brvalo | 05.58 | Em | 06.25 | | |
| 44612 | ma,di,do,vr | Esn | 23.33 | Rsd | 23.42 | Kfhn | 00.25/01.17 | Mvtw | 02.01 | | | | | Antwerpen Noord | GXN Rotterdam, UC |
| | wo | Esn | 23.33 | Rsd | 23.42 | Kfhn | 00.25/01.55 | Mvtw | 02.38 | | | | | | |
| 44613 | di-za | Mvtw | 02.56 | Kfhz | 03.42/05.36 | Rsd | 06.14/06.17 | Esn | 06.28 | | | | | Antwerpen Noord | GXN Rotterdam, UC |
| 44614 | ma-vr | Esn | 09.33 | Rsd | 09.42 | Kfhn | 10.25/10.59 | Gd | 11.33 | Ac | 12.10 | Awhv | 12.40 | Antwerpen Noord | GXN Rotterdam, UC |
| 44615 | ma-vr | Awhv | 13.44 | Ac | 14.17 | Wd | 14.45 | Rtd | 15.15/15.25 | Kfhn | 15.43/16.03 | Esn | 16.53 | Antwerpen Noord | GXN Rotterdam, UC |
| 44620 | ma | Hmt | 23.41 | Wt | 00.23/00.55 | Rm | 01.17 | Std | 01.43 | Lutdsm | 01.53 | | | Antwerpen Noord | Ketelwagens |
| | di-vr | Fvs | 05.58 | Mt | 06.15 | Std | 06.42/07.10 | Lutdsm | 07.18 | | | | | | |
| 44621 | ma-vr | Lutdsm | 09.04 | Std | 09.12/09.49 | Mt | 10.16 | Fvs | 10.31 | | | | | Antwerpen Noord | Ketelwagens |
| 44622 | ma-vr | Fsz | 09.48 | Svg | 09.58/10.11 | Slua | 10.32 | Sludow | 10.57 | | | | | Antwerpen Noord | Afhaken wgs Yara in Svg |
| 44623 | ma-vr | Sludow | 12.19 | Slua | 12.34/12.56 | Svg | 13.17/13.57 | Fsz | 14.07 | | | | | Antwerpen Noord | Aanhaken wgs Yara in Svg |
| 44624 | ma | Hmt | 05.24 | Wt | 06.00/06.04 | Rm | 06.25 | Std | 06.49 | Lutdsm | 06.59 | | | Antwerpen Noord | |
| 44625 | di | Lutdsm | 03.10 | Std | 03.18/03.48 | Mt | 04.16 | Fvs | 04.31 | | | | | Antwerpen Noord | |
| 44709 | di-za | Mvtw | 01.56 | Kfhn | 02.39/02.53 | Brgnd | 03.10 | Brmet | 03.32 | Brvalo | 03.58 | Em | 04.25 | Köln Eifeltor | * |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44710 | ma-vr | Em | 21.39 | Brvalo | 22.06 | Brmet | 22.33 | Brgnd | 22.54 | Kfhn | 23.12/23.36 | Mvtw | 00.21 | Köln Eifeltor | |
| 45500 | wo,za | Vl | 01.09/01.25 | Ehv | 02.06 | Tb | 02.34 | Bd | 02.49 | Rsd | 03.11 | Esn | 03.21 | München-Antwerpen | Ing, 01-04, GXN Oberbayern, UC |
| | do,vr | Vl | 01.09/01.20 | Ehv | 02.06 | Ht | 02.30 | Ut | 03.07 | Gd | 03.34 | Rtd | 03.56 | | |
| | | Kfhn | 04.08 | Rsd | 04.45 | Esn | 04.53 | | | | | | | | |
| 45502 | wo-za | Vl | 13.32/13.51 | Ehv | 14.32 | Tb | 15.02 | Bd | 15.19 | Rsd | 15.42/15.43 | Esn | 15.53 | Augsburg-Antwerpen | Ingaande 01-04 |
| 45504 | ma | Vl | 07.11/07.21 | Ehv | 08.02 | Tb | 08.32 | Bd | 08.49 | Rsd | 09.10/09.17 | Esn | 09.27 | Augsburg-Antwerpen | Ingaande 01-04 |
| 45506 | zo | Vl | 17.32/17.37 | Ehv | 18.17 | Tb | 18.44 | Bd | 18.59 | Rsd | 19.17 | Esn | 19.27 | München-Antwerpen | Ing. 01-04, GXN Oberbayern, UC |
| 45708 | wo | Kn | 14.10 | Vl | 14.19/15.45 | Rm | 16.16 | Std | 16.41/16.51 | Lutdsm | 16.59 | | | Dormagen | |
| 46150 | di,vr,za | Kn | 16.40 | Vl | 16.49/17.22 | Ehv | 18.02 | Tb | 18.32 | Bd | 18.49 | Rsd | 19.11/19.17 | Bratislava/Wenen-Antwerp. | GXN Austria/Slovakia Xpress, UC |
| 46152 | wo | Vl | 16.52/17.22 | Ehv | 18.02 | Tb | 18.32 | Bd | 18.49 | Rsd | 19.11/19.17 | Esn | 19.27 | Bratislava/Wels-Antwerp. | GXN Austria/Slovakia Xpress, UC |
| 46156 | do | Vl | 16.53/17.22 | Ehv | 18.02 | Tb | 18.32 | Bd | 18.49 | Rsd | 19.11/19.17 | Esn | 19.27 | Bratislava/Wenen-Antwerp. | GXN Austria/Slovakia Xpress, UC |
| 46158 | zo | Vl | 17.02/17.07 | Ehv | 17.47 | Tb | 18.14 | Bd | 18.29 | Rsd | 18.54 | Esn | 19.03 | Bratislava/Wenen-Antwerp. | GXN Austria/Slovakia Xpress, UC |
| 46250 | za | Esn | 17.33 | Rsd | 17.42 | Bd | 18.02 | Tb | 18.17 | Ht | 18.42 | Gdm | 19.00/19.07 | Transit Gent-Älmhult | Volvo |
| | | Ut | 19.29 | Amf | 19.46 | Sto | 20.03/20.07 | Dv | 20.40 | Aml | 21.12 | Bh | 22.03 | | |
| 46251 | zo | Bh | 09.32 | Hgl | 09.58 | Aml | 10.09 | Dv | 10.37 | Amf | 11.22/11.43 | Wp | 12.14 | Transit Gent-Älmhult | Volvo |
| | | Wd | 12.47 | Rtd | 13.22/13.25 | Kfhn | 13.41 | Rsd | 14.17 | Esn | 14.27 | | | | |
| 46252 | vr | Esn | 17.33 | Rsd | 17.42/18.06 | Bd | 18.28 | Tb | 18.47 | Ht | 19.11 | Gdm | 19.29/19.37 | Transit Gent-Älmhult | Volvo |
| | | Ut | 19.59 | Amf | 20.16 | Sto | 20.33/20.51 | Dv | 21.23 | Aml | 21.51 | Bh | 22.24 | | |
| 46253 | di-za | Bh | 08.58 | Aml | 09.39 | Dv | 10.07 | Apd | 10.18 | Amf | 10.52/11.12 | Ut | 11.35 | Transit Älmhult-Gent | Volvo |
| | | Gdm | 11.56/11.59 | Ht | 12.19 | Bd | 12.49 | Rsd | 13.11/13.17 | Esn | 13.27 | | | | |
| 46254 | ma-do | Esn | 17.33 | Rsd | 17.42/18.06 | Bd | 18.28 | Tb | 18.47 | Ht | 19.11 | Gdm | 19.29/19.37 | Transit Gent-Älmhult | Volvo |
| | | Ut | 19.59 | Amf | 20.16 | Sto | 20.33/20.51 | Dv | 21.23 | Aml | 21.51 | Bh | 22.24 | | |
| 46256 | di,wo | Esn | 01.33 | Rsd | 01.42/02.03 | Ht | 03.00 | Ah | 03.48 | Dvge | 04.23/05.09 | Bh | 06.24 | Transit Gent-Älmhult | Volvo |
| | do,vr | Esn | 01.33 | Rsd | 01.43 | Kfh | 02.25/02.48 | Amf | 04.35 | Dv | 05.22 | Bh | 06.24 | | |
| | za | Esn | 01.33 | Rsd | 01.42/02.23 | Ht | 03.20 | Amf | 04.25 | Dv | 05.15 | Bh | 06.24 | | |
| 46257 | ma-zo | Bh | 17.32 | Aml | 18.09 | Dv | 18.37 | Apd | 18.50 | Amf | 19.21/19.43 | Wp | 20.14 | Transit Gent-Älmhult | Volvo |
| | | Wd | 20.47 | Rtd | 21.22/21.25 | Kfhz | 21.44/21.46 | Rsd | 22.19 | Esn | 22.28 | | | | |
| 46258 | za | Esn | 19.48 | Rsd | 19.57/20.21 | Bd | 20.42 | Tb | 20.58 | Ht | 21.13 | Gdm | 21.31/21.37 | Transit Gent-Älmhult | Volvo |
| | | Ut | 21.59 | Amf | 22.16 | Sto | 22.33/22.51 | Dv | 23.23 | Hgl | 00.02 | Bh | 00.24 | | |
| 46259 | ma | Bh | 05.48 | Aml | 06.39 | Dv | 07.07 | Apd | 07.20 | Amf | 07.51/08.43 | Wp | 09.14 | Transit Gent-Älmhult | Volvo |
| | | Wd | 09.47 | Rtd | 10.22/10.25 | Kfhn | 10.41 | Rsd | 11.18 | Esn | 11.27 | | | | |
| 46260 | ma-za | Esn | 05.45 | Rsd | 05.57/06.06 | Bd | 06.28 | Tb | 06.47 | Ht | 07.11 | Gdm | 07.29/07.32 | Antwerpen-Malmö | FM, GXN Sweden Xpress, UC |
| | | Ut | 07.53 | Amf | 08.15 | Sto | 08.32/08.51 | Dv | 09.23 | Aml | 09.50 | Bh | 10.24 | | |
| 46261 | ma,di,vr | Bh | 21.22 | Aml | 22.10 | Dvge | 22.36/22.56 | Ah | 23.45 | Brmet | 00.29 | Ht | 00.44 | Antwerpen-Malmö | FM, GXN Sweden Xpress, UC |
| | | Tb | 01.02 | Rsd | 01.35/01.52 | Esn | 02.03 | | | | | | | | |
| | wo,do | Bh | 21.22 | Aml | 22.10 | Dv | 22.37 | Apd | 22.50 | Amf | 23.23/23.43 | Wp | 00.14 | | |
| | | Wd | 00.47 | Rtd | 01.16 | Kfhn | 01.30/01.34 | Rsd | 02.15/02.18 | Esn | 02.29 | | | | |
| 46262 | zo | Esn | 06.28 | Rsd | 06.57/07.06 | Bd | 07.28 | Tb | 07.47 | Ht | 08.12 | Gdm | 08.30/08.37 | Antwerpen-Malmö | FM, GXN Sweden Xpress, UC |
| | | Ut | 08.59 | Amf | 09.16 | Sto | 09.33/09.51 | Dv | 10.23 | Aml | 10.50 | Bh | 11.24 | | |
| 46263 | zo | Bh | 06.01 | Aml | 06.39 | Dv | 07.07 | Apd | 07.20 | Amf | 07.53 | Wp | 08.19 | Antwerpen-Malmö | FM, GXN Sweden Xpress, UC |
| | | Wd | 08.47 | Rtd | 09.16/09.25 | Kfhz | 09.44/10.36 | Rsd | 11.14/11.17 | Esn | 11.27 | | | | |
| 47520 | ma-vr | Vl | 14.19/14.21 | Ehv | 15.02 | Tb | 15.32 | Bd | 15.49 | Rsd | 16.11/16.17 | Esn | 16.27 | Köln Eifeltor-Antwerpen N. | FM, GXN Köln Shuttle I, UC |
| 47527 | ma-vr | Esn | 06.45 | Rsd | 06.57/07.06 | Bd | 07.28 | Tb | 07.47 | Ehv | 08.13 | Vl | 08.50/09.11 | Köln Eifeltor-Antwerpen N. | FM, GXN Köln Shuttle I, UC |
| 47531 | ma-vr | Esn | 16.45 | Rsd | 16.57/17.06 | Bd | 17.28 | Tb | 17.47 | Ehv | 18.13 | Vl | 18.50/19.37 | Köln Eifeltor-Antwerpen N. | FM, GXN Köln Shuttle II, UC |
| 47534 | wo-vr | Kn | 10.40 | Vl | 10.49/11.15 | Rm | 11.45 | Std | 12.07/12.48 | Mt | 13.16 | Fvs | 13.31 | Millingen-Yves Gomezée | Leeg kalk, wo FM |
| | za | Kn | 10.40 | Vl | 10.49/11.15 | Rm | 11.45 | Std | 12.07/12.18 | Mt | 12.46 | Fvs | 13.01 | | |
| 47535 | ma-vr | Fvs | 23.29 | Mt | 23.45 | Std | 00.10/00.20 | Rm | 00.45/00.46 | Vl | 01.14/01.49 | Kn | 02.00 | Yves Gomezée-Millingen | Kalk |
| 45737 | zo | Fvs | 20.59 | Mt | 21.15 | Std | 21.42/22.56 | Rm | 23.15 | Vl | 23.44/00.11 | Kn | 00.23 | Yves Gomezée-Millingen | Kalk |
| 47538 | di,wo,za | Kn | 00.10 | Vl | 00.19/00.22 | Ehv | 01.05 | Tb | 01.32 | Rsd | 02.12/02.16 | Esn | 02.27 | Köln Eifeltor-Antwerpen N. | GXN Köln Shuttle II, UC |
| 47561 | di,wo | Fvs | 07.29 | Mt | 07.45 | Std | 08.12/08.56 | Rm | 09.15 | Vl | 09.44/10.14 | Kn | 10.27 | Yves Gomezée-Millingen | FM, Kalk |
| 47566 | ma,di | Kn | 09.30 | Vl | 09.39/10.16 | Rm | 10.45 | Std | 11.07/11.49 | Mt | 12.16 | Fvs | 12.31 | Millingen-Yves Gomezée | Leeg kalk |
| 47568 | di,wo | Kn | 17.39 | Vl | 17.48/18.15 | Rm | 18.45 | Std | 19.07/19.48 | Mt | 20.16 | Fvs | 20.31 | Millingen-Yves Gomezée | Leeg kalk |
| 47601 | wo,vr | Zlw | 14.24 | Rsd | 14.47/14.57 | Esn | 15.08 | | | | | | | Virton | Kalkslurry |
| 47617 | ma-vr | Bdl | 13.20 | Bdlg | 13.37 | Hmt | 13.42 | Lnp | 13.53 | | | | | Antwerpen Groenland | Leeg zinkerts |
| 47618 | ma-vr | Lnp | 06.28 | Hmt | 06.39 | Bdlg | 06.44 | Bdl | 07.05 | | | | | Antwerpen Groenland | Zinkerts |
| 47620 | ma | Fsz | 07.56 | Svg | 08.05/08.09 | Slua | 08.30 | Tnzz | 08.40/09.07 | Axa | 09.17 | | | Saint-Ghislain | FM, bediening Yara |
| 47621 | ma | Axa | 10.56 | Tnzz | 11.06/11.25 | Slua | 11.35 | Svg | 11.56/12.01 | Fsz | 12.11 | | | Saint-Ghislain | FM, bediening Yara |
| 47624 | wo,vr | Esn | 12.32 | Rsd | 12.41 | Zlw | 13.00 | | | | | | | Gent | Leeg kalkslurry |
| 47627 | ma,wo,vr | Vdma* | 23.30 | On | 23.53/08.05 | Hgv | 08.46/08.54 | Zl | 09.31 | Amf | 10.21/10.44 | Gdm | 11.26/11.30 | Hermalle | Dolime |
| | | Ht | 11.49 | Ehv | 12.13 | Wt | 12.34 | Rm | 12.51 | Std | 13.11/13.48 | Fvs | 14.31 | | *Vdma-On op di,do,zo |
| 47628 | di,do | Fvs | 10.29 | Std | 11.11/11.26 | Wt | 12.01/12.22 | Ehv | 12.47 | Gdm | 13.29/13.32 | Ut | 13.53 | Hermalle | Dolime |
| | | Amf | 14.15 | Pt | 14.34/14.48 | Zl | 15.27 | Hgv | 16.00 | On | 16.33/18.12 | Vdma | 18.39 | | |
| | za | Fvs | 09.59 | Std | 10.42/11.26 | Wt | 12.01/12.22 | Ehv | 12.47 | Gdm | 13.29/13.32 | Ut | 13.53 | | |
| | | Amf | 14.15 | Pt | 14.34/14.48 | Zl | 15.27 | Hgv | 16.00 | On | 16.33/18.42 | Vdma | 19.09 | | |
| 47631 | ma-vr | Sloe | 10.02 | Krg | 10.37 | Rsd | 11.14/11.42 | Esn | 11.54 | | | | | Antwerpen Noord | Ingaande 01-04, FM |
| 47632 | ma-vr | Esn | 06.32 | Rsd | 06.44/07.39 | Krg | 08.17 | Sloe | 08.51 | | | | | Antwerpen Noord | Ingaande 01-04, FM |

*Rijdt niet van week 29 t/m week 34

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| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47730 | di | Kn | 01.33 | Vl | 01.42/03.29 | Tb | 04.41 | Rsd | 05.14 | Krg | 05.42 | Sloe | 06.12 | | Ford auto's |
| | wo | Kn | 01.33 | Vl | 01.42/02.12 | Tb | 03.20 | Rsd | 03.53 | Krg | 04.25 | Sloe | 04.56 | | |
| | do,vr | Kn | 01.33 | Vl | 01.42/04.17 | Tb | 05.24 | Rsd | 05.56 | Krg | 06.23 | Sloe | 06.50 | | |
| | za | Kn | 01.33 | Vl | 01.42/01.53 | Tb | 03.02 | Rsd | 03.40 | Krg | 04.07 | Sloe | 04.35 | | |
| 47732 | ma-vr | Kn | 10.02 | Vl | 10.11/10.22 | Ehv | 11.02 | Tb | 11.32 | Bd | 11.49 | Rsd | 12.11/12.12 | Dillingen | Ford auto's |
| | | Krg | 12.42 | Sloe | 13.12 | | | | | | | | | | |
| 47733 | ma,wo,vr | Amf | 11.02 | Sto | 11.21/11.51 | Apd | 12.09 | Dv | 12.22 | Aml | 12.50 | Bh | 13.24 | Osnabrück | Leeg VW auto's/gesl wgns, rijdt niet* |
| | ma,wo-vr | Amf | 11.02 | Sto | 11.21 | Apd | 11.38 | Dv | 11.53 | Aml | 12.21/12.50 | Bh | 13.24 | Osnabrück, do ing 1-4 | Leeg VW auto's/gesl wgns, rijdt* |
| 47734 | ma,wo-vr | Bh | 07.57 | Hgl | 08.23/08.26 | Aml | 08.39 | Dv | 09.07 | Apd | 09.20 | Amf | 09.53 | Osnabrück, do ing 1-4 | VW auto's+onderdelen |
| 47735 | ma,di | Sloe | 23.39 | Rsd | 00.42 | Vl | 02.22/02.55 | Kn | 03.04 | | | | | Dillingen | Leeg Ford auto's |
| | wo,do | Sloe | 23.05 | Rsd | 00.06 | Vl | 01.51/02.55 | Kn | 03.04 | | | | | | |
| 47737 | ma-vr | Sloe | 15.33 | Krg | 16.04 | Rsd | 16.36 | Bd | 16.58 | Tb | 17.17 | Ehv | 17.43 | Dillingen | Leeg Ford auto's |
| | | Vl | 18.20/18.28 | Kn | 18.37 | | | | | | | | | | |
| 47739 | za | Sloe | 00.05 | Rsd | 01.07 | Vl | 02.51/02.54 | Kn | 03.03 | | | | | Dillingen | Leeg Ford auto's |
| 48575 | ma,wo,do | Esn | 07.05 | Rsd | 07.16/07.52 | Kfhn | 08.27/10.53 | Brgnd | 11.10 | Brmet | 11.32 | Ah | 12.15 | Zeebrugge - Osnabrück | Leeg Daimler auto's, Hccrrs'n |
| | | Zp | 12.43 | Dvge | 12.59/13.24 | Aml | 13.49/13.51 | Odz | 14.12 | Bh | 14.24 | | | | |
| | za | Esn | 06.34 | Rsd | 06.44/07.17 | Kfhn | 07.51/10.47 | Brgnd | 11.00 | Brcup | 11.50/11.58 | Ah | 12.15 | | |
| | | Zp | 12.43 | Dvge | 12.59/13.24 | Aml | 13.49/13.51 | Odz | 14.12 | Bh | 14.24 | | | | |
| 48576 | ma,di,do,vr | Bh | 18.32 | Aml | 19.09/19.10 | Dvge | 19.37/19.56 | Zp | 20.16 | Ah | 20.45 | Brmet | 21.22 | Osnabrück-Zeebrugge | Daimler auto's, Hccrrs'n |
| | | Ht | 21.46 | Tb | 22.02 | Rsd | 22.42/23.58 | Esn | 00.08 | | | | | | |

* Van week 24 t/m week 35

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| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46601 | do | Bot | 12.10 | Kfhn | 12.29/13.14 | Rtng | 13.38/14.48 | Wd | 15.14 | Wp | 15.46 | Amf | 16.15 | Ziar nad Hronom | Aluminiumoxide |
| | | Sto | 16.32/16.37 | Apd | 16.57 | Dv | 17.09 | Aml | 17.45 | Bh | 18.24 | | | | |
| 46603 | za/zo | Bot | 12.40 | Kfhn | 12.59/18.43 | Brmet | 19.23 | Brcup | 19.49/19.59 | Ah | 20.15 | Dvge | 20.59/21.41 | Ziar nad Hronom | Aluminiumoxide |
| | | Aml | 22.15 | Odz | 22.40/08.10 | Bh | 08.24 | | | | | | | | |
| 46604 | zo/ma | Bh | 18.58 | Aml | 19.39 | Dvge | 20.07/20.56 | Dr | 21.30 | Brcup | 21.59/22.05 | Brmet | 22.33 | Ziar nad Hronom | Leeg aluminiumoxide |
| | | Kfhn | 23.13/08.44 | Bot | 09.09 | | | | | | | | | | |
| 46605 | di | Bot | 11.10 | Kfhn | 11.29/12.59 | Gd | 13.33 | Wp | 14.16 | Amf | 14.45 | Sto | 15.02/15.07 | Ziar nad Hronom | Aluminiumoxide |
| | | Apd | 15.27 | Dv | 15.39 | Aml | 16.15 | Odz | 16.40/16.46 | Bh | 17.01 | | | | |
| 46606 | do | Bh | 19.58 | Aml | 20.39 | Dvge | 21.07/21.56 | Dr | 22.30 | Brcup | 22.59/23.05 | Brmet | 23.33 | Ziar nad Hronom | Leeg aluminiumoxide |
| | | Kfhn | 00.12/00.45 | Bot | 01.10 | | | | | | | | | | |
| 46608 | wo | Bh | 00.46 | Aml | 01.24 | Dvge | 01.54/02.29 | Dr | 03.00 | Brcup | 03.29/03.36 | Brmet | 04.03 | Ziar nad Hronom | Leeg aluminiumoxide |
| | | Kfhn | 04.42/07.38 | Bot | 08.03 | | | | | | | | | | |
| 47509 | ma-vr | Fvs | 14.29 | Mt | 14.45 | Std | 15.12/15.56 | Wt | 16.27 | Ehv | 16.48 | Ht | 17.11 | Renory-Bremen Stahlw. | Leeg openlucht staal |
| | | Brmet | 17.27 | Brcup | 17.55/17.59 | Dr | 18.31 | Dvge | 18.59/19.41 | Aml | 20.15/21.08 | Bh | 22.02 | | |
| 47510 | di | Bh | 06.32 | Aml | 07.12/09.43 | Dvge | 10.17/10.56 | Dr | 11.30 | Ahb | 11.47/12.07 | Nm | 12.25/12.42 | Bremen Stahlw.-Renory | Openlucht staal |
| | | Ht | 13.18 | Ehv | 13.43 | Wt | 14.04 | Std | 14.41/15.48 | Mt | 16.16 | Fvs | 16.31 | | |
| | wo,vr | Bh | 06.32 | Aml | 07.12/09.43 | Dvge | 10.17/10.56 | Dr | 11.30 | Ahb | 11.47/12.07 | Nm | 12.25/12.42 | | |
| | | Ht | 13.18 | Ehv | 13.43 | Wt | 14.04 | Std | 14.41/17.48 | Mt | 18.16 | Fvs | 18.31 | | |
| | do | Bh | 06.32 | Aml | 07.12/09.43 | Dvge | 10.17/10.56 | Dr | 11.30 | Ahb | 11.47/12.07 | Nm | 12.25 | | |
| | | Ht | 13.03/13.16 | Ehv | 13.43 | Wt | 14.04 | Std | 14.41/15.48 | Mt | 16.16 | Fvs | 16.31 | | |
| | za | Bh | 06.32 | Aml | 07.12/09.43 | Dvge | 10.17/10.56 | Dr | 11.30 | Ahb | 11.47/12.07 | Nm | 12.25/12.42 | | |
| | | Ht | 13.18 | Ehv | 13.43 | Wt | 14.04 | Std | 14.41/17.18 | Mt | 17.46 | Fvs | 18.01 | | |
| 47511 | za/zo | Fvs | 14.02 | Mt | 14.15 | Std | 14.42/15.56 | Wt | 16.27 | Ehv | 16.47 | Ht | 17.11 | Renory-Bremen Stahlw. | Leeg openlucht staal |
| | | Brmet | 17.31 | Brvalo | 18.02 | Dr | 18.31 | Dvge | 18.59/19.41 | Aml | 20.15/14.14 | Bh | 15.07 | | |
| 47512 | zo/ma | Bh | 23.18 | Aml | 00.04/09.43 | Dvge | 10.17/10.56 | Dr | 11.30 | Ahb | 11.47/12.07 | Nm | 12.25/12.42 | Bremen Stahlw.-Renory | Openlucht staal |
| | | Ht | 13.18 | Ehv | 13.43 | Wt | 14.04 | Std | 14.41/17.48 | Mt | 18.16 | Fvs | 18.31 | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47612 | ma,di | Fvs | 21.29 | Std | 22.09/23.34 | Ehv | 00.28 | Dt | 02.19 | Bvge | 03.25/04.00 | Bvhc | 04.06 | Jemelle | Kalk |
| | wo,do | Fvs | 21.29 | Std | 22.11/23.34 | Ehv | 00.31 | Asd | 02.38 | Utg | 03.02/03.20 | Bvhc | 03.33 | | |
| | vr | Fvs | 21.29 | Std | 22.11/23.34 | Ehv | 00.31 | Asd | 02.14 | Bvge | 02.50/04.00 | Bvhc | 04.06 | | |
| | zo | Fvs | 09.59 | Std | 10.42/11.56 | Wt | 12.32/12.53 | Ehv | 13.17 | Ht | 13.41 | Gdm | 13.59/14.02 | | |
| | | Ut | 14.24 | Asd | 15.00 | Hlm | 15.17 | Bvge | 15.35/16.22 | Bvhc | 16.29 | | | | |
| 47613 | ma-vr | Bvhc | 18.35 | Bvge | 18.42/19.24 | Hlm | 19.43 | Asd | 20.01 | Ut | 20.32 | Gdm | 20.53/20.59 | Jemelle | Leeg kalk/beladen staal |
| | | Ht | 21.19 | Ehv | 21.43 | Std | 22.39/00.19 | Mt | 00.45 | Fvs | 01.01 | | | | |
| | zo | Bvhc | 06.25 | Bvge | 06.31/07.26 | Hlm | 07.43 | Asd | 08.01 | Ut | 08.32 | Gdm | 08.53/08.59 | | |
| | | Ht | 09.19 | Ehv | 09.43 | Wt | 10.04 | Rm | 10.21 | Std | 10.41/12.19 | Fvs | 13.01 | | |
| 47706 | ma,wo,vr-zo | Em | 14.49 | Brvalo | 15.16 | Brmet | 15.43/15.57 | Ut | 16.24 | Asd | 17.02 | Awhv | 17.11 | Oberhausen | Leeg kolen |
| 47712 | di | Em | 08.59 | Brvalo | 09.26 | Brmet | 09.53/09.57 | Ut | 10.24 | Asd | 11.02 | Awhv | 11.11 | Oberhausen | Leeg kolen |
| | do | Em | 08.39 | Brvalo | 09.06 | Brmet | 09.32 | Ut | 9.54 | Asd | 10.33 | Awhv | 10.41 | | |
| | zo | Em | 08.29 | Brvalo | 08.56 | Gdm | 09.28/09.37 | Ut | 09.58 | Asd | 10.32 | Awhv | 10.41 | | |
| 47726 | zo | Vl | 20.32/21.21 | Ehv | 22.02 | Tb | 22.32 | Rsd | 23.11/23.12 | Krg | 23.42 | Sloe | 00.12 | Stolberg | Leeg looderts |
| 47728 | wo | Vl | 02.17/02.37 | Ehv | 03.17 | Tb | 03.43 | Rsd | 04.14 | Krg | 04.42 | Sloe | 05.11 | Stolberg | Leeg looderts |
| | vr | Vl | 02.17/02.19 | Ehv | 03.03 | Ut | 04.04 | Rtd | 04.51 | Rsd | 05.38 | Sloe | 06.34 | | |
| 47729 | ma,wo,vr | Sloe | 17.16 | Krg | 17.47 | Rsd | 18.19 | Tb | 18.59 | Ehv | 19.30 | Vl | 20.07/20.12 | Stolberg | Looderts |
| 47731 | za | Bot | 05.49 | Kfhn | 06.09/06.13 | Brgnd | 06.30 | Brmet | 06.52 | Brvalo | 07.18 | Em | 07.45 | Singen | Aluminiumblokken |
| 47748 | zo | Em | 15.29 | Brvalo | 15.56 | Brmet | 16.22/16.27 | Mas | 17.02/17.31 | Asd | 18.00 | Hlm | 18.17 | Flandersbach | Kalk |
| | | Bvge | 18.35/18.55 | Bvhc | 19.02 | | | | | | | | | | |
| 47749 | zo | Bvhc | 07.26 | Bvge | 07.33/07.58 | Hlm | 08.13 | Asd | 08.31 | Mas | 08.57 | Gdm | 09.21 | Flandersbach | Leeg kalk |
| | | Brcup | 09.57/10.04 | Em | 10.35 | | | | | | | | | | |
| 47750 | ma-vr | Em | 16.39 | Brcup | 17.09/17.26 | Brmet | 17.52/17.56 | Ut | 18.24 | Asd | 19.00 | Hlm | 19.17 | Flandersbach | Kalk |
| | | Bvge | 19.34/20.05 | Bvhc | 20.11 | | | | | | | | | | |
| 47751 | ma-vr | Bvhc | 07.46 | Bvge | 07.52/08.27 | Hlm | 08.43 | Asd | 09.01 | Ut | 09.35 | Gdm | 09.55 | Flandersbach | Leeg kalk/beladen staal |
| | | Brvalo | 10.28 | Em | 10.55 | | | | | | | | | | |
| 47756 | ma | Kn | 19.04 | Vl | 19.13/20.45 | Rm | 21.15 | Std | 21.37 | Lutdsm | 21.47 | | | Großenkneten | Zwavel |
| 47757 | wo | Lutdsm | 04.44 | Std | 04.52 | Rm | 05.16 | Vl | 05.44/06.20 | Kn | 06.28 | | | Großenkneten | Leeg zwavel |
| 47760 | vr | Em | 00.39 | Brvalo | 01.06 | Brmet | 01.33 | Brgnd | 01.54 | Kfhn | 02.10/02.15 | Erp | 02.45 | Weißig | Leeg methanol |
| 47761 | zo | Erp | 16.08 | Kfhn | 16.39/17.13 | Brgnd | 17.30 | Brmet | 17.52 | Brvalo | 18.18 | Em | 18.45 | Weißig | Methanol |
| 47764 | di,vr | Em | 05.59 | Brvalo | 06.26 | Brmet | 06.52 | Brgnd | 07.14 | Kfhn | 07.32/07.51 | Erp | 08.21 | Wackerwerk-Burghausen | Leeg methanol |
| 47765 | wo/do | Erp | 03.18 | Kfhn | 03.49/12.12 | Brgnd | 12.30 | Brmet | 12.52 | Brvalo | 13.18 | Em | 13.45 | Wackerwerk-Burghausen | Methanol |
| 47766 | ma | Kn | 23.15 | Vl | 23.24/02.09 | Rm | 02.40 | Std | 03.15/03.19 | Lutdsm | 03.27 | | | Gladbeck | Fenol |
| | wo | Kn | 23.15 | Vl | 23.24/01.39 | Rm | 02.03 | Std | 02.27 | Lutdsm | 02.33 | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | vr | Kn | 23.15 | Vl | 23.25/00.15 | Rm | 00.47 | Std | 01.14 | Lutdsm | 01.22 | | | | |
| 47767 | ma,do | Lutdsm | 23.34 | Std | 23.42/23.53 | Rm | 00.15 | Vl | 00.43/01.07 | Kn | 01.15 | | | Gladbeck | Leeg fenol |
| | vr | Lutdsm | 22.50 | Std | 22.57 | Rm | 23.15 | Vl | 23.44/01.07 | Kn | 01.15 | | | | |
| 47769 | za/zo | Erp | 14.14 | Kfhn | 14.52/13.43 | Brgnd | 14.00 | Brmet | 14.22 | Brvalo | 14.48 | Em | 15.15 | Wackerwerk-Burghausen | Methanol |
| 48541 | di,zo | Hrp | 13.17 | Asd | 13.28 | Ut | 14.05 | Gdm | 14.25 | Brvalo | 14.58 | Em | 15.25 | München | Kolen |
| 48570 | di,do-za | Em | 04.39 | Brcup | 05.10/06.03 | Kfhz | 07.09/08.37 | Zlw | 08.56 | Rsd | 09.17 | Esn | 09.27 | Schkopau/Buna – Sludow | Ketelwagens/gesl.wgns |
| 48571 | ma,wo-vr | Esn | 17.05 | Rsd | 17.16 | Kfhn | 17.55/20.11 | Brgnd | 20.30 | Brcup | 21.20/21.40 | Em | 22.15 | Sludow - Schkopau/Buna | Ketelwagens/gesl.wgns |
| 48701 | ma-vr | Mvt | 19.35 | Kfhn | 20.19/20.23 | Brgnd | 20.40 | Brmet | 21.02 | Brvalo | 21.28 | Em | 21.55 | Großkrotzenburg | Kolen |
| 48703 | zo | Mvt | 15.45 | Kfhn | 16.29/16.43 | Brgnd | 17.00 | Brmet | 17.22 | Brvalo | 17.48 | Em | 18.15 | Großkrotzenburg | Kolen |
| 48708 | di-vr | Em | 07.49 | Brvalo | 08.16 | Brmet | 08.43 | Brgnd | 09.04 | Kfhn | 09.20/09.26 | Mvt | 10.08 | Dillingen | Leeg erts |
| 48710 | di-vr | Em | 13.49 | Brvalo | 14.16 | Brmet | 14.43 | Brgnd | 15.04 | Kfhn | 15.19 | Mvt | 16.10 | Dillingen | Leeg erts |
| 48711 | di-za | Mvt | 01.45 | Kfhn | 02.29/02.43 | Brgnd | 03.00 | Brmet | 03.22 | Brvalo | 03.48 | Em | 04.15 | Dillingen | Erts |
| 48712 | di-vr | Em | 16.29 | Brvalo | 16.56 | Brmet | 17.23 | Brgnd | 17.44 | Kfhn | 18.00/18.06 | Mvt | 18.46 | Dillingen | Leeg erts |
| 48713 | ma-za | Mvt | 06.25 | Kfhn | 07.09/07.23 | Brgnd | 07.40 | Brmet | 08.02 | Brvalo | 08.28 | Em | 08.55 | Dillingen | Erts |
| 48714 | di-vr | Em | 20.39 | Brvalo | 21.06 | Brmet | 21.33 | Brgnd | 21.54 | Kfhn | 22.12/22.36 | Mvt | 23.18 | Dillingen | Leeg erts |
| 48715 | ma-za | Mvt | 09.25 | Kfhn | 10.09/11.13 | Brgnd | 11.30 | Brmet | 11.52 | Brvalo | 12.18 | Em | 12.45 | Dillingen | Erts |
| 48716 | di-za | Em | 00.49 | Brvalo | 01.16 | Brmet | 01.43 | Brgnd | 02.04 | Kfhn | 02.20/02.26 | Mvt | 03.06 | Dillingen | Leeg erts |
| 48717 | ma-za | Mvt | 13.46 | Kfhn | 14.29/15.23 | Brgnd | 15.40 | Brmet | 16.02 | Brvalo | 16.28 | Em | 16.55 | Dillingen | Erts |
| 48718 | di-za | Em | 04.49 | Brvalo | 05.16 | Brmet | 05.43 | Brgnd | 06.05 | Kfhn | 06.23/07.10 | Mvt | 07.54 | Dillingen | Leeg erts |
| 48719 | ma-vr | Mvt | 17.35 | Kfhn | 18.19/19.23 | Brgnd | 19.40 | Brmet | 20.02 | Brvalo | 20.28 | Em | 20.55 | Dillingen | Erts |
| 48720 | za | Em | 12.29 | Brvalo | 12.56 | Brmet | 13.23 | Brgnd | 13.44 | Kfhn | 14.02/14.08 | Mvt | 14.51 | Dillingen | Leeg erts |
| | zo | Em | 12.29 | Brvalo | 12.56 | Brmet | 13.23 | Brgnd | 13.44 | Kfhn | 14.02/15.09 | Mvt | 15.51 | | |
| 48721 | ma-vr | Mvt | 22.05 | Kfhn | 22.55/23.02 | Brgnd | 23.20 | Brmet | 23.42 | Brvalo | 00.08 | Em | 00.35 | Dillingen | Erts |
| 48722 | zo | Em | 19.29 | Brvalo | 19.56 | Brmet | 20.23 | Brgnd | 20.44 | Kfhn | 21.02/21.06 | Mvt | 21.54 | Dillingen | Leeg erts |
| 48724 | za,zo | Em | 20.09 | Brvalo | 20.36 | Brmet | 21.03 | Brgnd | 21.24 | Kfhn | 21.42/21.46 | Mvt | 22.31 | Dillingen | Leeg erts |
| 48726 | ma | Em | 06.59 | Brvalo | 07.26 | Brmet | 07.53 | Brgnd | 08.14 | Kfhn | 08.32/08.36 | Mvt | 09.22 | Dillingen | Leeg erts |
| 48727 | di,do | Awhv | 17.13 | Asd | 17.28 | Ut | 18.05 | Brmet | 18.28 | Brvalo | 18.58 | Em | 19.25 | Mannheim | Kolen |
| | zo | Awhv | 17.50 | Asd | 18.03 | Ut | 18.35 | Brmet | 18.59/19.16 | Brvalo | 19.48 | Em | 20.15 | | |
| 48728 | zo | Em | 15.09 | Brvalo | 15.36 | Brmet | 16.03 | Brgnd | 16.24 | Kfhn | 16.42/16.46 | Mvt | 17.34 | Dillingen | Leeg erts |
| 48729 | ma-za | Mvt | 16.55 | Kfhn | 17.39/18.03 | Brgnd | 18.20 | Brmet | 18.42 | Brvalo | 19.08 | Em | 19.35 | Dillingen | Kolen |
| 48730 | ma-wo | Em | 08.19 | Brvalo | 08.46 | Brmet | 09.13/09.29 | Ut | 09.54 | Asd | 10.32 | Hrp | 10.45 | Oberhausen | Leeg kolen |
| | zo | Em | 07.56 | Brvalo | 08.25 | Brmet | 08.52 | Ut | 09.16 | Asd | 09.46 | Hrp | 10.00 | | |
| 48731 | ma-za | Mvt | 03.05 | Kfhn | 03.49/03.53 | Brgnd | 04.10 | Brmet | 04.32 | Brvalo | 04.58 | Em | 05.25 | Gladbeck | Kolen |
| 48732 | za | Em | 11.50 | Brvalo | 12.17 | Brmet | 12.43/12.57 | Ut | 13.24 | Asd | 14.02 | Hrp | 14.14 | Oberhausen | Leeg kolen |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48733 | ma-vr,zo | Mvt | 22.55 | Kfhn | 23.42/23.48 | Brgnd | 00.10 | Brmet | 00.31 | Brvalo | 00.58 | Em | 01.25 | Gladbeck | Kolen |
| 48734 | vr | Em | 06.59 | Brvalo | 07.26 | Brmet | 07.52/07.57 | Ut | 08.24 | Asd | 09.02 | Hrp | 09.15 | Oberhausen | Leeg kolen |
| 48735 | vr | Hrp | 19.17 | Asd | 19.28 | Ut | 20.03 | Brmet | 20.28/20.47 | Brvalo | 21.18 | Em | 21.45 | Frankfurt | Kolen |
| 48736 | ma,za | Em | 22.39 | Brvalo | 23.04 | Gdm | 23.34/23.37 | Ut | 23.58 | Asd | 00.31 | Hrp | 00.45 | Oberhausen | Leeg kolen |
| 48737 | ma-do,zo | Awhv | 06.43 | Asd | 06.58 | Ut | 07.35 | Brmet | 07.58/08.15 | Brvalo | 08.48 | Em | 09.15 | Karlsruhe | Kolen |
| 48738 | ma-wo,zo | Em | 22.59 | Brvalo | 23.26 | Gdm | 23.59/00.07 | Ut | 00.28 | Asd | 01.02 | Awhv | 01.11 | Oberhausen | Leeg kolen |
| 48739 | ma-do | Hrp | 07.47 | Asd | 07.58 | Ut | 08.35 | Brmet | 08.59/09.16 | Brvalo | 09.48 | Em | 10.15 | München | Kolen |
| 48740 | vr | Em | 18.49 | Brvalo | 19.16 | Brmet | 19.43 | Kfhn | 20.20/20.48 | Erp | 21.16/02.40 | Erpw | 02.55 | Duisburg HKM | Leeg kolen |
| | zo | Em | 18.49 | Brvalo | 19.16 | Brmet | 19.43 | Kfhn | 20.20/20.25 | Erp | 20.54/22.45 | Erpw | 23.00 | | |
| 48741 | za | Mvt | 21.05 | Kfhn | 21.49/22.03 | Brgnd | 22.20 | Brmet | 22.42 | Brvalo | 23.08 | Em | 23.35 | Gratwein | Kolen |
| 48742 | zo | Em | 10.09 | Brvalo | 10.36 | Brmet | 11.03 | Brgnd | 11.24 | Kfhn | 11.40/11.45 | Mvt | 12.32 | Oberhausen | Leeg kolen |
| 48743 | ma-za | Mvt | 04.45 | Kfhn | 05.29/05.33 | Brgnd | 05.50 | Brmet | 06.12 | Brvalo | 06.38 | Em | 07.05 | Dillingen | Kolen |
| 48744 | ma-vr,zo | Em | 11.49 | Brvalo | 12.16 | Brmet | 12.43 | Brgnd | 13.04 | Kfhn | 13.20/13.25 | Mvt | 14.12 | Oberhausen | Leeg kolen |
| 48745 | zo | Mvt | 21.55 | Kfhn | 22.39/22.43 | Brgnd | 23.00 | Brmet | 23.22 | Brvalo | 23.48 | Em | 00.15 | Anglberg | Kolen |
| 48746 | za | Em | 01.29 | Brvalo | 01.56 | Brmet | 02.22/02.27 | Ut | 02.54 | Asd | 03.30 | Hrp | 03.45 | Oberhausen | Leeg kolen |
| 48747 | ma-do,zo | Awhv | 12.44 | Asd | 12.58 | Ut | 13.35 | Brmet | 13.58 | Brvalo | 14.28 | Em | 14.55 | Plochingen | Kolen |
| 48748 | ma-vr | Em | 14.09 | Brvalo | 14.36 | Brmet | 15.03 | Kfhn | 15.42/15.47 | Erp | 16.16/20.30 | Erpw | 20.45 | Duisburg HKM | Leeg kolen |
| 48750 | zo | Em | 11.09 | Brvalo | 11.36 | Brmet | 12.03 | Brgnd | 12.24 | Kfhn | 12.42/12.46 | Mvt | 13.31 | Oberhausen | Leeg kolen |
| 48752 | ma-za | Em | 02.09 | Brvalo | 02.36 | Brmet | 03.03 | Brgnd | 03.24 | Kfhn | 03.42/03.47 | Mvt | 04.28 | Oberhausen | Leeg kolen |
| 48754 | ma-vr,zo | Em | 23.59 | Brvalo | 00.26 | Brmet | 00.53 | Brgnd | 01.14 | Kfhn | 01.30/01.37 | Mvt | 02.22 | Oberhausen | Leeg kolen |
| 48755 | ma-vr,zo | Mvt | 15.24 | Kfhn | 16.09/16.23 | Brgnd | 16.40 | Brmet | 17.02 | Brvalo | 17.28 | Em | 17.55 | Fürstenhausen | Kolen |
| 48756 | ma-do,zo | Em | 22.19 | Brvalo | 22.46 | Brmet | 23.13 | Brgnd | 23.35 | Kfhn | 23.50/00.04 | Mvt | 00.52 | Oberhausen | Leeg kolen |
| 48758 | ma-vr | Em | 19.09 | Brvalo | 19.36 | Brmet | 20.03 | Brgnd | 20.24 | Kfhn | 20.40/20.46 | Mvt | 21.31 | Oberhausen | Leeg kolen |
| | zo | Em | 19.39 | Brvalo | 20.06 | Brmet | 20.33 | Brgnd | 20.54 | Kfhn | 21.11/21.20 | Mvt | 22.05 | | |
| 48759 | ma-za | Erpw | 06.03 | Erp | 06.14/08.28 | Kfhn | 08.59/09.03 | Brmet | 09.42 | Brvalo | 10.08 | Em | 10.35 | Duisburg HKM | Kolen |
| 48760 | ma | Em | 08.39 | Brvalo | 09.06 | Brmet | 09.34/09.51 | Brgnd | 10.15 | Kfhn | 10.31/10.36 | Mvt | 11.21 | Oberhausen | Leeg kolen |
| | di,wo,vr | Em | 08.39 | Brvalo | 09.06 | Brmet | 09.33 | Brgnd | 09.54 | Kfhn | 10.14/10.18 | Mvt | 11.03 | | |
| | do | Em | 09.19 | Brvalo | 09.46 | Brmet | 10.13 | Brgnd | 10.34 | Kfhn | 10.50/10.54 | Mvt | 11.39 | | |
| 48761 | za | Hrp | 18.47 | Asd | 18.58 | Ut | 19.35 | Brmet | 19.59/20.36 | Brvalo | 21.08 | Em | 21.35 | München | Kolen |
| 48762 | za | Em | 14.59 | Brvalo | 15.26 | Brmet | 15.53 | Brgnd | 16.14 | Kfhn | 16.32/16.34 | Mvt | 17.21 | Oberhausen | Leeg kolen |
| 48763 | za | Erpw | 13.03 | Erp | 13.14/20.08 | Kfhn | 20.39/20.43 | Brmet | 21.22 | Brvalo | 21.48 | Em | 22.15 | Duisburg HKM | Kolen |
| 48764 | za | Em | 10.19 | Brvalo | 10.46 | Brmet | 11.13 | Brgnd | 11.34 | Kfhn | 11.51 | Mvt | 12.36 | Oberhausen | Leeg kolen |
| 48766 | di | Em | 06.59 | Brvalo | 07.26 | Brmet | 07.52/07.57 | Ut | 08.24 | Asd | 09.02 | Awhv | 09.11 | Oberhausen | Leeg kolen |
| 48767 | zo | Hrp | 18.47 | Asd | 18.58 | Ut | 19.35 | Brmet | 19.59/20.26 | Brvalo | 20.58 | Em | 21.25 | Plochingen | Kolen |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48970 | di,do | Em | 12.19 | Brvalo | 12.46 | Brmet | 13.13 | Brgnd | 13.34 | Kfhn | 13.52 | | | Herzogenburg | Leeg styreen |
| 48971 | za | Kfhz | 09.26 | Brgnd | 09.40 | Brmet | 10.02 | Brvalo | 10.28 | Em | 10.55 | | | Herzogenburg | Styreen |
| 48973 | di | Kfhz | 08.16 | Brgnd | 08.30 | Brmet | 08.52 | Brvalo | 09.18 | Em | 09.45 | | | Herzogenburg | Styreen |
| 49710 | ma | Em | 12.09 | Brvalo | 12.36 | Brmet | 13.03 | Brgnd | 13.24 | Kfhn | 13.42/14.24 | Mvt | 15.10 | Dillingen | Leeg erts |
| 49712 | ma | Em | 15.49 | Brvalo | 16.16 | Brmet | 16.43 | Brgnd | 17.04 | Kfhn | 17.20/17.26 | Mvt | 18.08 | Dillingen | Leeg erts |
| 49713 | za/zo | Mvt | 21.35 | Kfhn | 22.19/08.03 | Brgnd | 08.20 | Brmet | 08.42 | Brvalo | 09.08 | Em | 09.35 | Dillingen | Erts |
| 49714 | za,zo | Em | 08.59 | Brvalo | 09.26 | Brmet | 09.53 | Brgnd | 10.14 | Kfhn | 10.30/10.36 | Mvt | 11.24 | Dillingen | Leeg erts |
| 49715 | zo | Mvt | 11.35 | Kfhn | 12.19/13.13 | Brgnd | 13.30 | Brmet | 13.52 | Brvalo | 14.18 | Em | 14.45 | Dillingen | Erts |
| 49716 | za | Em | 16.49 | Brvalo | 17.16 | Brmet | 17.43 | Brgnd | 18.04 | Kfhn | 18.20/18.26 | Mvt | 19.14 | Dillingen | Leeg erts |
| 49717 | zo | Mvt | 14.25 | Kfhn | 15.09/15.13 | Brgnd | 15.30 | Brmet | 15.52 | Brvalo | 16.18 | Em | 16.45 | Dillingen | Erts |
| 49719 | za | Mvt | 17.25 | Kfhn | 18.09/19.23 | Brgnd | 19.40 | Brmet | 20.02 | Brvalo | 20.28 | Em | 20.55 | Dillingen | Erts |
| 49721 | za | Mvt | 21.15 | Kfhn | 21.59/22.23 | Brgnd | 22.39 | Brmet | 23.02 | Brvalo | 23.33 | Em | 00.00 | Dillingen | Erts |
| 49726 | zo | Em | 07.49 | Brvalo | 08.15 | Brmet | 08.43 | Brgnd | 09.05 | Kfhn | 09.23/09.26 | Mvt | 10.10 | Dillingen | Leeg erts |
| 61260 | di,wo | Kfhz | 03.21 | Rtd | 03.43 | Gv | 04.04 | Lis | 04.36 | Bvge | 05.03/05.29 | Bvhc | 05.36 | | Leeg staal |
| | do,vr | Kfhz | 04.26 | Rtd | 04.44 | Wd | 05.14 | Asd | 05.44 | Bvge | 06.25/06.41 | Bvhc | 06.48 | | |
| | za | Kfhz | 03.12 | Rtd | 03.31 | Gv | 03.49 | Lis | 04.11 | Bvge | 04.36/05.07 | Bvhc | 05.14 | | |
| 61261 | ma-za | Kfhn | 14.15 | Rtd | 14.31 | Gv | 14.55 | Ledn | 15.12/15.23 | Bvge | 16.05/16.35 | Bvhc | 16.40 | | Leeg staal |
| 61265 | zo | Kfhz | 09.12 | Rtd | 09.31 | Gv | 09.56 | Ledn | 10.12/10.23 | Bvge | 11.00/11.22 | Bvhc | 11.27 | | Leeg staal |
| 61601 | ma-za | Bvhc | 09.22 | Bvge | 09.29/09.57 | Lis | 10.29/10.40 | Gv | 11.07 | Rtd | 11.27 | Kfhn | 11.45 | | Staal |
| 61604 | ma-vr | Bvhc | 21.13 | Bv | 21.18/21.22 | Utg | 21.31/22.00 | Awhv | 22.28 | | | | | | Staal |
| 61606 | za | Bvhc | 15.13 | Bv | 15.18/15.22 | Utg | 15.31/16.00 | Awhv | 16.33 | | | | | | Staal |

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Stand: 01-01-19 (versie2019a)

| Treinnr | Dagen* | Tijden | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45766 | wo | Bh | 10.47 | Hgl | 11.16/11.22 | Ddn | 11.29/11.37 | Ddnser | 11.41 | | | | | | Bediening KLK Kolb |
| 45767 | wo | Ddnser | 12.14 | Ddn | 12.19/12.27 | Hgl | 12.35/12.44 | Bh | 13.10 | | | | | | Bediening KLK Kolb |
| 61011 | ma-vr | Kfhz | 22.51 | Bot | 23.25 | | | | | | | | | | |
| 61013 | ma-za | Kfhz | 06.22 | Bot | 06.54 | | | | | | | | | | |
| 61014 | di-za | Kfhz | 01.20 | Bot | 01.55 | | | | | | | | | | |
| 61017 | ma-vr | Kfhz | 09.03 | Ps | 09.27 | | | | | | | | | | |
| 61030 | ma,di,vr | Kfhz | 23.51 | Gd | 00.28 | Asb | 01.01 | Lls | 01.38 | On | 03.31 | | | | |
| | do | Kfhz | 23.54 | Gd | 00.37 | Amf | 01.54 | Zl | 02.54 | On | 04.14 | | | | |
| 61063 | ma-vr | Kfhz | 21.02 | Rtng | 21.29/21.48 | Wd | 22.14 | Asd | 23.02 | Awhv | 23.11 | | | | |
| 61070 | ma-vr | Kfhz | 05.33 | Rsd | 06.11 | Krg | 06.42 | Sloe | 07.12 | | | | | | |
| | za | Kfhz | 06.33 | Rsd | 07.11 | Krg | 07.42 | Lwd | 08.02/08.22 | Sloe | 08.32 | | | | |
| 61071 | ma-vr | Kfhz | 13.33 | Zlw | 13.52 | Rsd | 14.11 | Krg | 14.42 | Lwd | 15.02 | Sloe | 15.12 | | |
| 61073 | ma | Kfhz | 16.33 | Zlw | 16.52 | Rsd | 17.11 | Krg | 17.40 | Lwd | 18.00 | Sloe | 18.10 | | Tot 1 april |
| 61104 | ma-vr | Bot | 13.18 | Kfhn | 13.45 | | | | | | | | | | |
| | za | Bot | 12.06 | Kfhn | 12.35 | | | | | | | | | | |
| 61105 | ma | Bot | 20.26 | Kfhn | 20.55 | | | | | | | | | | |
| 61106 | ma-vr | Bot | 22.36 | Kfhn | 23.05 | | | | | | | | | | |
| 61107 | ma-vr | Ps | 15.44 | Whz | 15.51 | | | | | | | | | | |
| 61110 | ma-vr | Kfhz | 13.59 | Ps | 14.23 | Erp | 14.41 | Mvtw | 14.59/16.25 | Mvten | 16.50 | | | | |
| 61111 | ma-vr | Mvten | 17.45 | Mvtw | 18.10/19.19 | Bot | 19.49 | Kfhn | 20.15 | | | | | | |
| 61122 | ma-vr | Kfhz | 14.40 | Whz | 14.58 | | | | | | | | | | |
| 61123 | ma-vr | Whz | 21.10 | Kfhn | 21.25 | | | | | | | | | | |
| 61132 | ma-vr | Kfhz | 23.12 | Erp | 23.54 | | | | | | | | | | |
| 61133 | di-za | Erp | 04.05 | Kfhn | 04.46 | | | | | | | | | | |
| 61186 | ma,di | Kfhz | 21.33 | Ehv | 22.43 | Rm | 23.23 | Std | 23.43/00.55 | Lutdsm | 01.10 | | | | |
| | wo-vr | Kfhz | 21.33 | Ehv | 22.43 | Rm | 23.21 | Std | 23.41/02.01 | Lutdsm | 02.16 | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61300 | ma,di,do,vr | On | 18.15 | Asn | 18.34 | Hgv | 18.55 | Zl | 19.30 | Stb | 19.58/20.08 | Alm | 20.41 |
| | | Wp | 20.56 | Hmlba | 21.31/21.40 | Gd | 21.58 | Rtd | 22.22/22.31 | Kfhn | 22.48 | | |
| 61600 | ma-vr | Awhv | 23.45 | Asd | 23.58 | Bkl | 00.24 | Gd | 00.48 | Kfhn | 01.20 | | |
| 61701 | ma-vr | Sloe | 09.13 | Gs | 09.36 | Bgn | 10.04 | Rsd | 10.16 | Zlw | 10.34 | Kfhn | 10.55 |
| 61702 | ma-vr | Sloe | 17.10 | Gs | 17.33 | Bgn | 18.01 | Rsd | 18.13 | Zlw | 18.34 | Kfhn | 18.55 |
| 61816 | ma-vr | Lutdsm | 14.33 | Std | 14.43/15.26 | Rm | 15.45 | Wt | 16.02/16.37 | Ehv | 17.01 | Tb | 17.32 |
| | | Bd | 17.48 | Zlw | 17.59 | Kfhn | 18.22 | | | | | | |
| 62002 | ma-za | Kfhz | 05.14 | Zlw | 05.37 | | | | | | | | |
| 62003 | ma-vr | Zlw | 14.02 | Kfhn | 14.28 | | | | | | | | |
| | za | Zlw | 11.03 | Kfhn | 11.28 | | | | | | | | |
| 62004 | ma-vr | Kfhz | 06.02 | Zlw | 06.27 | | | | | | | | |
| 62005 | ma-vr | Zlw | 23.02 | Kfhn | 23.28 | | | | | | | | |
| 62008 | ma-vr | Kfhz | 15.32 | Zlw | 15.56 | | | | | | | | |
| 62014 | ma,wo | Zlw | 10.35 | Otw | 11.05 | | | | | | | | |
| 62015 | ma,wo | Otw | 12.40 | Zlw | 13.10 | | | | | | | | |
| 62020 | di-vr | Kfhn | 05.17 | Ddri | 05.35 | | | | | | | | |
| | za | Kfhn | 05.51 | Ddri | 06.09 | | | | | | | | |
| 62022 | ma-vr | Kfhz | 18.06 | Ddr | 18.15 | Ddri | 18.22 | | | | | | |
| | za | Kfhn | 15.34 | Ddr | 15.45 | Ddri | 15.52 | | | | | | |
| 62023 | ma-vr | Ddri | 20.21 | Ddr | 20.28 | Kfhn | 20.37 | | | | | | |
| | za | Ddri | 17.23 | Ddr | 17.31 | Kfhn | 17.40/18.58 | Ps | 19.16 | Erp | 19.36 | | |
| 62028 | di | Kfhz | 13.36 | Ddr | 13.45 | | | | | | | | |
| 62029 | di | Ddr | 16.50 | Kfhn | 17.03 | | | | | | | | |
| 62070 | ma,di,do,vr | Kfhz | 19.38 | Rtng | 20.09/20.19 | Gd | 20.35 | | | | | | |
| 62071 | ma,di,do,vr | Apn | 22.51 | Wad | 23.03/23.07 | Gd | 23.16 | | | | | | |
| 62072 | ma,di,do,vr | Gd | 21.04 | Wad | 21.14/21.22 | Apn | 21.32 | | | | | | |
| 62073 | ma,di,do,vr | Gd | 23.50 | Rtd | 00.10 | Kfhn | 00.26 | | | | | | |
| 62087 | ma-vr | Mdk | 13.12 | Zlw | 13.37 | | | | | | | | |
| | za | Mdk | 09.45 | Zlw | 10.10 | | | | | | | | |
| 62089 | wo | Mdk | 09.15 | Zlw | 09.40 | | | | | | | | |
| | vr | Mdk | 12.45 | Zlw | 13.10 | | | | | | | | |
| 62090 | ma-vr | Zlw | 16.20 | Mdk | 16.45 | | | | | | | | |
| 62094 | ma-za | Zlw | 05.57 | Mdk | 06.22 | | | | | | | | |
| 62096 | ma-vr | Zlw | 07.02 | Mdk | 07.27 | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62097 | ma-vr | Mdk | 21.37 | Zlw | 22.02 | | | | | | | | | |
| 62311 | di,wo,vr,za | On | 05.18 | Apg | 06.04/06.07 | Dz | 06.13 | | | | | | | |
| 62312 | ma,di,do,vr | Dz | 08.42 | Apg | 08.47/08.51 | Stm | 09.06/09.09 | Swd | 09.22 | Gn | 09.34/09.35 | On | 09.43 | |
| 62330 | ma,di,do,vr | On | 13.18 | Gn | 13.28 | Swd | 13.41 | Bf | 13.50/13.53 | Ust | 14.03/14.13 | Rdac | 14.26 | |
| 62333 | ma,di,do,vr | Rdac | 15.38 | Ust | 15.51/15.55 | Bf | 16.05/16.12 | Swd | 16.21 | Gn | 16.33/16.34 | On | 16.42 | |
| 62524 | wo | Kfhn | 14.03 | Zwd | 14.08 | | | | | | | | | |
| 62525 | wo | Zwd | 15.48 | Kfhn | 15.55 | | | | | | | | | |
| 62951 | ma,wo,vr | Std | 07.20 | Bon | 07.40 | | | | | | | | | |
| 62952 | ma,wo | Bon | 10.14 | Std | 10.34 | Lutdsm | 10.44 | | | | | | | |
| 62953 | ma-do | Std | 19.35 | Mt | 19.57 | | | | | | | | | |
| | vr | Std | 10.05 | Mt | 10.28 | | | | | | | | | |
| 62954 | ma-vr | Mt | 00.02 | Std | 00.25 | | | | | | | | | |
| 62955 | ma-do | Mt | 20.26 | Mttrix | 20.46 | | | | | | | | | |
| | vr | Mt | 10.51 | Mttrix | 11.11 | | | | | | | | | |
| 62956 | ma-do | Mttrix | 22.56 | Mt | 23.16 | | | | | | | | | |
| | vr | Mttrix | 13.26 | Mt | 13.46 | | | | | | | | | |
| 62957 | di,wo | Std | 02.00 | Lutdsm | 02.10 | | | | | | | | | |
| | do,vr | Std | 01.00 | Lutdsm | 01.10 | | | | | | | | | |
| 62958 | di,wo | Lutdsm | 05.00 | Std | 05.10 | | | | | | | | | |
| 62959 | vr | Std | 15.03 | Lutdsm | 15.13 | | | | | | | | | |
| 62960 | vr | Mt | 14.13 | Std | 14.36 | | | | | | | | | |
| 62990 | ma-vr | Vl | 19.10 | Br | 19.16 | | | | | | | | | Bediening Cabooter |
| 62991 | ma-vr | Br | 21.37 | Vl | 21.43 | | | | | | | | | Bediening Cabooter |
| 62994 | di,do | Vl | 07.46 | Br | 07.54 | | | | | | | | | Bediening Cabooter |

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Stand: 01-01-19 (versie2019a)

| Treinnr | Dagen* | Tijden | | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40021 | ma,wo | Bot | 23.39 | Kfhn | 23.59/00.03 | Brgnd | 00.20 | Brmet | 00.42 | Brvalo | 01.08 | Em | 01.35 | Brescia | |
| | di,do | Bot | 21.49 | Kfhn | 22.09/22.13 | Brgnd | 22.30 | Brmet | 22.52 | Brvalo | 23.18 | Em | 23.45 | | Ingaande 04-02 |
| 40022 | di-vr | Em | 18.29 | Brvalo | 18.56 | Brmet | 19.23 | Brgnd | 19.44 | Kfhn | 20.02/20.09 | Bot | 20.32 | Brescia | wo+vr ingaande 04-02 |
| 40023 | za | Bot | 11.30 | Kfhn | 11.49/19.03 | Brgnd | 19.20 | Brmet | 19.42 | Brvalo | 20.08 | Em | 20.35 | Brescia | |
| 40024 | zo | Em | 10.39 | Brvalo | 11.06 | Brmet | 11.33 | Brgnd | 11.54 | Kfhn | 12.12/12.19 | Bot | 12.42 | Brescia | |
| 41363 | di,do | Mvtw | 20.36 | Kfhn | 21.19/22.00 | Bd | 22.30 | Tb | 22.47 | Ehv | 23.13 | Vl | 23.53/00.50 | Mainz | |
| 41367 | zo | Mvtyn | 12.05 | Mvtwn | 12.30/16.50 | Mvtw | 16.55/17.56 | Kfhn | 18.39/20.08 | Bd | 20.42 | Tb | 20.59 | Mainz | |
| | | Ehv | 21.30 | Vl | 22.15/23.13 | Kn | 23.22 | | | | | | | | |
| 41370 | wo | Vl | 04.52/06.37 | Ehv | 07.17 | Tb | 07.44 | Zlw | 08.10/08.36 | Kfhn | 08.59/09.35 | Mvtw | 10.20 | Mainz | |
| 41371 | ma | Mvtw | 20.18 | Kfhn | 20.59/21.00 | Bd | 21.30 | Ehv | 22.13 | Vl | 22.51/23.50 | Kn | 23.59 | Mainz | |
| | wo | Mvtw | 20.46 | Kfhn | 21.29/21.38 | Bd | 22.12 | Ehv | 23.00 | Vl | 23.45/00.47 | Kn | 00.56 | | |
| 41372 | di,do | Kn | 04.43 | Vl | 04.51/05.22 | Ehv | 06.02 | Bd | 06.48 | Kfhn | 07.22/08.04 | Mvtw | 08.49 | Mainz | |
| | vr | Vl | 04.51/05.22 | Ehv | 06.02 | Bd | 06.48 | Kfhn | 07.22/08.01 | Mvtw | 08.45/10.34 | Mvtyn | 10.59 | | |
| | za | Vl | 04.51/05.22 | Bd | 06.48 | Kfhn | 07.22/07.31 | Mvtw | 08.17/12.45 | Mvtwn | 12.53/21.06 | Mvtyn | 21.25 | | |
| 41502 | ma | Vl | 05.21/06.22 | Ehv | 07.02 | Tb | 07.32 | Bd | 07.48 | Rsd | 08.12/08.31 | Esn | 08.43 | Ruhland-Antwerpen | |
| 41519 | ma | Esn | 17.37 | Rsd | 17.48/17.52 | Bd | 18.12 | Tb | 18.29 | Ehv | 19.00 | Vl | 19.41/20.17 | Ruhland-Antwerpen | |
| | wo,vr | Esn | 18.20 | Rsd | 18.31/18.38 | Bd | 18.59 | Tb | 19.17 | Ehv | 19.43/19.52 | Vl | 20.35/20.50 | | |
| 41520 | wo,vr | Vl | 11.11/11.21 | Ehv | 12.02 | Tb | 12.32 | Bd | 12.49 | Rsd | 13.10/13.26 | Esn | 13.35 | Ruhland-Antwerpen | |
| 41538 | di,do,za | Kn | 15.04 | Vl | 15.13/15.22 | Ehv | 16.02 | Tb | 16.32 | Rsd | 17.10/17.17 | Esn | 17.28 | Duisburg-Antwerpen | |
| 41539 | di,do,za | Esn | 00.03 | Rsd | 00.16 | Tb | 00.51 | Ehv | 01.19 | Vl | 02.00/02.37 | Kn | 02.46 | Duisburg-Antwerpen | |
| 41606 | ma,wo,vr | Esn | 21.32 | Rsd | 21.43 | | | | | | | | | Antwerpen Combinant | Hoyer-deel Nosta-shuttle |
| 41607 | di,do | Rsd | 22.31 | Esn | 22.41 | | | | | | | | | Antwerpen Combinant | Hoyer-deel Nosta-shuttle |
| | za | Rsd | 21.43 | Esn | 21.53 | | | | | | | | | | |
| 42526 | zo | Em | 23.29 | Brvalo | 23.56 | Brmet | 00.23 | Brgnd | 00.44 | Kfhn | 01.00/01.05 | Whz | 01.18 | Verona Quadrante Eu. | |
| 42527 | za/zo | Whz | 19.07 | Kfhn | 19.22/18.13 | Brgnd | 18.30 | Brmet | 18.52 | Brvalo | 19.18 | Em | 19.45 | Verona Quadrante Eu. | |
| 42528 | wo-za | Em | 06.09 | Brvalo | 06.36 | Brmet | 07.03 | Brgnd | 07.24 | Kfhn | 07.40/07.45 | Whz | 07.58 | Verona Quadrante Eu. | |
| 42529 | di-vr | Whz | 20.50 | Kfhn | 21.05/21.13 | Brgnd | 21.30 | Brmet | 21.52 | Brvalo | 22.18 | Em | 22.45 | Verona Quadrante Eu. | |
| 42530 | zo | Em | 08.49 | Brvalo | 09.16 | Brmet | 09.43 | Brgnd | 10.04 | Kfhn | 10.20/16.33 | Whz | 16.46 | Verona Quadrante Eu. | |
| 42531 | ma | Whz | 20.50 | Kfhn | 21.05/21.13 | Brgnd | 21.30 | Brmet | 21.52 | Brvalo | 22.18 | Em | 22.45 | Verona Quadrante Eu. | |
| 42537 | do | Lutdsm | 22.07 | Std | 22.15/22.55 | Rm | 23.15 | Vl | 23.44/00.20 | Kn | 00.28 | | | Verona Quadrante Eu. | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42542 | zo/ma | Kn | 21.04 | Vl | 21.12/05.13 | Rm | 05.38 | Std | 06.02/07.08 | Lutdsm | 07.18 | | | Verona Quadrante Eu. | |
| 42543 | za | Lutdsm | 14.05 | Std | 14.15/14.56 | Rm | 15.15 | Vl | 15.44/16.50 | Kn | 16.58 | | | Verona Quadrante Eu. | |
| 42550 | wo | Kn | 01.18 | Vl | 01.27/02.24 | Rm | 02.46 | Std | 03.17 | Lutdsm | 03.27 | | | Verona Quadrante Eu. | |
| | do-za | Kn | 01.18 | Vl | 01.27/02.00 | Rm | 02.27 | Std | 02.54 | Lutdsm | 03.00 | | | | |
| 42551 | ma-wo | Lutdsm | 22.07 | Std | 22.15/22.56 | Rm | 23.15 | Vl | 23.45/00.36 | Kn | 00.45 | | | Verona Quadrante Eu. | |
| 42607 | za/zo | Mvtw | 15.20 | Whz | 16.01/21.00 | Kfhn | 21.15/14.43 | Brmet | 15.22 | Brvalo | 15.48 | Em | 16.15 | Basel | |
| 42610 | di | Em | 07.29 | Brvalo | 07.46 | Brmet | 08.23 | Kfhn | 09.00/09.04 | Whz | 09.18/15.16 | Mvtw | 16.00 | Basel | |
| | wo,vr | Em | 07.29 | Brvalo | 07.46 | Brmet | 08.23 | Kfhn | 09.00/09.10 | Whz | 09.24/16.45 | Mvtw | 17.31 | | |
| | do | Em | 07.29 | Brvalo | 07.46 | Brmet | 08.23 | Kfhn | 09.00/09.10 | Whz | 09.24/17.40 | Mvtw | 18.25 | | |
| | za | Em | 07.29 | Brvalo | 07.46 | Brmet | 08.23 | Kfhn | 09.00/09.09 | Whz | 09.23/16.20 | Mvtw | 17.06 | | |
| 42611 | ma,di,do | Mvtw | 10.31 | Whz | 11.12/18.40 | Kfhn | 18.55/19.03 | Brmet | 19.42 | Brvalo | 20.08 | Em | 20.35 | Basel | |
| | wo | Mvtw | 11.11 | Whz | 11.54/18.40 | Kfhn | 18.55/19.03 | Brmet | 19.42 | Brvalo | 20.08 | Em | 20.35 | | |
| 42709 | ma | Whz | 23.21 | Kfhn | 23.35/23.53 | Brgnd | 00.10 | Brmet | 00.32 | Brvalo | 00.58 | Em | 01.25 | Ludwigshafen-Mannheim | |
| 42755 | zo | Whz | 17.00 | Kfhn | 17.15/17.43 | Brgnd | 18.00 | Brmet | 18.22 | Brvalo | 18.48 | Em | 19.15 | Ludwigshafen-Mannheim | |
| 42756 | za/zo | Kn | 20.53 | Vl | 21.02/21.37 | Ehv | 22.17 | Bd | 22.59 | Kfhn | 23.25/18.05 | Whz | 18.15 | Ludwigshafen-Mannheim | |
| 42758 | di-vr | Kn | 04.09 | Vl | 04.17/04.38 | Ehv | 05.17 | Bd | 05.59 | Kfhn | 06.28/06.35 | Whz | 06.48 | Ludwigshafen-Mannheim | |
| 42759 | di | Whz | 20.30 | Kfhn | 20.45/20.53 | Brgnd | 21.10 | Brmet | 21.32 | Brvalo | 21.58 | Em | 22.25 | Ludwigshafen-Mannheim | |
| | wo,do | Whz | 20.30 | Kfhn | 20.45/21.03 | Brgnd | 21.20 | Brmet | 21.42 | Brvalo | 22.08 | Em | 22.35 | | |
| 42763 | ma,vr | Sloe | 20.43 | Rsd | 21.46/23.06 | Ht | 00.11 | Nm | 00.53 | Dvge | 01.41/02.06 | Bh | 03.08 | Osnabrück | Nosta-shuttle |
| | wo | Sloe | 20.43 | Rsd | 21.46/23.05 | Ht | 00.10 | Ut | 00.53 | Dv | 02.00 | Bh | 03.08 | | |
| 42770 | di,do,za | Bh | 15.57 | Aml | 16.39 | Dv | 17.07/17.56 | Zp | 18.16 | Ah | 18.45 | Brvalo | 18.56 | Osnabrück-Sloe/Antwerpen | Nosta-shuttle |
| | | Brmet | 19.27 | Ht | 19.49 | Tb | 20.05 | Rsd | 20.42/21.12 | Krg | 21.42 | Sloe | 22.13 | | |
| 42992 | wo,vr | Kn | 22.40 | Vl | 22.48/23.07 | Ehv | 23.47 | Tb | 00.13 | Rsd | 00.44/00.46 | Esn | 00.55 | Swardzedz/Poznan-Antwerpen | |
| 42993 | di,do | Esn | 22.07 | Rsd | 22.17/22.34 | Tb | 23.17 | Ehv | 23.43 | Vl | 00.21/00.35 | Kn | 00.45 | Antwerpen-Swardzedz/Poznan | |
| 42994 | ma | Kn | 08.15 | Vl | 08.23/08.37 | Ehv | 09.17 | Tb | 09.44 | Rsd | 10.26/10.44 | Esn | 10.53 | Swardzedz/Poznan-Antwerpen | |
| 42997 | za | Esn | 13.15 | Rsd | 13.27/13.36 | Tb | 14.17 | Ehv | 14.43 | Vl | 15.21/15.37 | Kn | 15.45 | Antwerpen-Swardzedz/Poznan | |
| 62040 | ma,wo,vr | Mvtaho | 01.00 | Mvtw | 01.15/04.26 | Kfhn | 05.09/05.38 | Bd | 06.12 | Ehv | 07.00 | Vl | 07.45 | Blerick | Cabooter |
| 62041 | ma,wo,vr | Vl | 14.07 | Ehv | 14.47 | Zlw | 15.40/15.58 | Kfhn | 16.22/16.26 | Mvtw | 17.06/18.16 | Mvtaho | 18.32 | Blerick | Cabooter |
| 62050 | ma | Mvtyn | 03.00 | Mvtw | 03.24/06.46 | Kfhn | 07.29/08.00 | Bd | 08.42 | Tb | 08.59 | Tbi | 09.02 | | |
| | di,do,za | Mvtw | 06.46 | Kfhn | 07.29/08.00 | Bd | 08.42 | Tb | 08.59 | Tbi | 09.02 | | | | |
| | wo | Mvtaho | 05.25 | Mvtw | 05.31/06.46 | Kfhn | 07.29/08.00 | Bd | 08.42 | Tb | 08.59 | Tbi | 09.02 | | |
| | vr | Mvtyn | 04.15 | Mvtw | 04.39/06.46 | Kfhn | 07.29/08.00 | Bd | 08.42 | Tb | 08.59 | Tbi | 09.02 | | |
| 62052 | ma | Tbi | 13.03 | Bd | 13.31 | Zlw | 13.45/13.58 | Kfhn | 14.25/14.35 | Mvtw | 15.28/16.35 | Mvtyn | 17.00 | | |
| | di-do | Tbi | 13.03 | Bd | 13.31 | Zlw | 13.45/13.58 | Kfhn | 14.24/14.35 | Mvtw | 15.27 | | | | |
| | vr | Tbi | 13.03 | Bd | 13.31 | Zlw | 13.45/13.58 | Kfhn | 14.24/14.35 | Mvtw | 15.27/23.00 | Mvtahw | 23.15 | | |
| | za | Tbi | 13.03 | Bd | 13.31 | Zlw | 13.46/14.28 | Kfhn | 14.56/15.03 | Mvtw | 15.55 | | | | |
| 62060 | ma | Mvtyn | 02.45 | Mvtw | 03.09/03.26 | Kfhn | 04.09/06.34 | Bd | 07.12 | Tb | 07.29 | At | 07.55 | | |
| | di | Mvtyn | 02.50 | Mvtw | 03.14/05.15 | Kfhn | 05.59/06.34 | Bd | 07.12 | Tb | 07.29 | At | 07.55 | | |
| | wo,vr | Mvtw | 04.56 | Kfhn | 05.41/06.34 | Bd | 07.12 | Tb | 07.29 | At | 07.55 | | | | |
| | do | Mvtahw | 03.45 | Mvtw | 04.00/04.35 | Kfhn | 05.22/06.33 | Bd | 07.12 | Tb | 07.29 | At | 07.55 | | |
| 62061 | ma,vr | At | 13.43 | Tb | 14.14 | Bd | 14.33 | Zlw | 14.46/15.02 | Kfhn | 15.28/15.31 | Mvtw | 16.25 | | |
| | di | At | 13.43 | Tb | 14.14 | Zlw | 14.46/15.02 | Kfhn | 15.28/15.31 | Mvtw | 16.25/17.15 | Mvtahw | 17.30 | | |
| | wo | At | 13.43 | Tb | 14.14 | Zlw | 14.46/15.02 | Kfhn | 15.28/15.31 | Mvtw | 16.25/16.45 | Mvtyn | 17.10 | | |
| | do | At | 13.43 | Tb | 14.14 | Zlw | 14.46/15.02 | Kfhn | 15.28/15.31 | Mvtw | 16.25/21.35 | Mvtyn | 22.00 | | |
| 62996 | ma,wo,vr | Vl | 08.40 | Br | 08.45 | | | | | | | | | | Cabooter |
| 62997 | ma | Br | 11.48 | Vl | 11.52 | | | | | | | | | | Cabooter |
| | wo,vr | Br | 11.37 | Vl | 11.42 | | | | | | | | | | |
| 62998 | ma,wo,vr | Vl | 09.40 | Br | 09.45 | | | | | | | | | | Cabooter |
| 62999 | ma,wo,vr | Br | 10.37 | Vl | 10.42 | | | | | | | | | | Cabooter |

| Dienstregeling goederentreinen | | | | | Disclaimer: zie onderaan | | | | | | | | | | © : Rolandrail.net |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stand: 01-01-19 | | (versie2019a) | | | | | | | | | | | | | |
| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | Van/Naar | Opmerkingen |
| 44601 | di-za | Kfhz | 00.37 | Rsd | 01.19 | Esn | 01.30 | | | | | | | Gent Zeehaven | Wagens Zw.Vl. |
| 44602 | ma-vr | Esn | 21.48 | Rsd | 22.01/22.06 | Kfhn | 22.55 | | | | | | | Gent Zeehaven | Wagens Zw.Vl. |
| 44604 | di,do-za | Esn | 05.29 | Rsd | 05.41 | Odb | 05.50/06.20 | Kfhn | 06.55 | | | | | Antwerpen Waaslandhaven | |
| | wo | Esn | 05.29 | Rsd | 05.41/06.16 | Kfhn | 06.55 | | | | | | | | |
| 44605 | ma-vr | Kfhz | 22.36 | Zlw | 22.56 | Rsd | 23.14 | Esn | 23.25 | | | | | Antwerpen Waaslandhaven | |
| 44609 | ma-vr | Kfhz | 12.03 | Zlw | 12.24 | Rsd | 12.47/12.58 | Esn | 13.10 | | | | | Antwerpen Kanaaldok | |
| 44610 | ma,wo | Esn | 20.32 | Rsd | 20.43 | Zlw | 21.04 | Kfhn | 21.28 | | | | | Antwerpen Kanaaldok | |
| | di,do,vr | Esn | 19.05 | Rsd | 19.16 | Zlw | 19.35 | Kfhn | 19.59 | | | | | | |
| 44616 | ma-vr | Esn | 16.14 | Rsd | 16.26 | Odb | 16.34/16.54 | Kfhn | 17.28 | | | | | Gent Zeehaven | Wagens Zw.Vl. |
| 44617 | ma-vr | Kfhz | 09.32 | Zlw | 09.55 | Rsd | 10.19 | Esn | 10.31 | | | | | Gent Zeehaven | Wagens Zw.Vl. |
| 45704 | di-za | Em | 03.39 | Brvalo | 04.06 | Brmet | 04.33 | Brgnd | 04.54 | Kfhn | 05.12 | | | Köln Gremberg | |
| 45710 | di-vr | Em | 10.49 | Brvalo | 11.16 | Brmet | 11.43 | Brgnd | 12.04 | Kfhn | 12.20 | | | Köln Gremberg | |
| 45711 | di-do | Kfhz | 22.07 | Brgnd | 22.20 | Brmet | 22.42 | Brvalo | 23.08 | Em | 23.35 | | | Köln Gremberg | Vanaf 1-4 |
| 45712 | za | Em | 10.29 | Brvalo | 10.56 | Brmet | 11.23 | Brgnd | 11.44 | Kfhn | 12.00 | | | Köln Gremberg | |
| 45713 | di-za | Kfhz | 01.56 | Brgnd | 02.10 | Brmet | 02.32 | Brvalo | 02.58 | Em | 03.25 | | | Köln Gremberg | |
| 45715 | di-za | Kfhz | 05.56 | Brgnd | 06.10 | Brmet | 06.32 | Brvalo | 06.58 | Em | 07.25 | | | Mannheim-Rheinau | |
| 45716 | di-za | Em | 14.29 | Brvalo | 14.56 | Brmet | 15.23 | Brgnd | 15.44 | Kfhn | 16.00 | | | Köln Gremberg | |
| 45717 | di-za | Kfhz | 10.16 | Brgnd | 10.30 | Brmet | 10.52 | Brvalo | 11.18 | Em | 11.45 | | | Köln Gremberg | |
| 45719 | di-za | Kfhz | 13.16 | Brgnd | 13.30 | Brmet | 13.52 | Brvalo | 14.18 | Em | 14.45 | | | Köln Gremberg | |
| 45720 | zo | Em | 17.29 | Brvalo | 17.56 | Brmet | 18.23 | Brgnd | 18.44 | Kfhn | 19.02 | | | Köln Gremberg | |
| 45722 | di-za | Em | 20.59 | Brvalo | 21.26 | Brmet | 21.53 | Brgnd | 22.14 | Kfhn | 22.30 | | | Köln Gremberg | |
| 45723 | za | Kfhz | 17.26 | Brgnd | 17.40 | Brmet | 18.02 | Brvalo | 18.28 | Em | 18.55 | | | Köln Gremberg | |
| 45725 | di-vr | Sloe | 09.01 | Krg | 09.34 | Rsd | 10.06 | Bd | 10.28 | Ehv | 11.13 | Vl | 11.51/11.59 | Köln Gremberg | |
| 45726 | zo | Em | 21.29 | Brvalo | 21.56 | Brmet | 22.23 | Brgnd | 22.44 | Kfhn | 23.02 | | | Köln Gremberg | |
| 45727 | ma-vr | Sloe | 18.42 | Krg | 19.14 | Rsd | 19.41 | Bd | 20.00 | Ehv | 20.43 | Vl | 21.21/21.46 | Köln Gremberg | |
| 45728 | di-za | Em | 02.49 | Brvalo | 03.16 | Brmet | 03.43 | Brgnd | 04.04 | Kfhn | 04.20 | | | Köln Gremberg | |
| 45729 | za | Sloe | 19.03 | Krg | 19.34 | Rsd | 20.06 | Bd | 20.28 | Ehv | 21.13 | Vl | 21.51/22.20 | Köln Gremberg | |
| 45730 | ma-vr | Kn | 14.52 | Vl | 15.02 | | | | | | | | | Köln Gremberg | Wagens Blerick |
| 45731 | di-za | Vl | 07.10 | Kn | 07.21 | | | | | | | | | Köln Gremberg | Wagens Blerick |
| 45732 | di-vr | Kn | 06.23 | Vl | 06.32/07.15 | Rm | 07.47 | Std | 08.11/09.37 | Lutdsm | 09.47 | | | Köln Gremberg | |
| 45736 | za | Kn | 06.02 | Vl | 06.11/08.15 | Rm | 08.45 | Std | 09.07/10.07 | Lutdsm | 10.17 | | | Köln Gremberg | |
| 45737 | ma-vr | Lutdsm | 18.34 | Std | 18.42/18.56 | Rm | 19.15 | Vl | 19.44/20.36 | Kn | 20.44 | | | Köln Gremberg | |
| 45738 | zo/ma | Kn | 22.53 | Vl | 23.01/06.45 | Rm | 07.15 | Std | 07.37/08.37 | Lutdsm | 08.47 | | | Köln Gremberg | |
| 45741 | di-za | Kfhz | 05.16 | Brgnd | 05.30 | Brmet | 05.52 | Brvalo | 06.18 | Em | 06.45 | | | Hagen Vorhalle | |
| 45742 | ma-za | Em | 21.29 | Brvalo | 21.56 | Brmet | 22.23 | Brgnd | 22.44 | Kfhn | 23.02 | | | Hagen Vorhalle | |
| 45743 | za | Kfhz | 14.46 | Brgnd | 15.00 | Brmet | 15.22 | Brvalo | 15.48 | Em | 16.15 | | | Hagen Vorhalle | |
| 45744 | zo | Em | 23.09 | Brvalo | 23.36 | Brmet | 00.03 | Brgnd | 00.24 | Kfhn | 00.40 | | | Hagen Vorhalle | |
| 45745 | ma-za | Kfhz | 12.57 | Brgnd | 13.11 | Brmet | 13.33 | Brvalo | 13.59 | Em | 14.25 | | | Hagen Vorhalle | |
| 45746 | di-za | Em | 09.49 | Brvalo | 10.16 | Brmet | 10.43 | Brgnd | 11.04 | Kfhn | 11.20 | | | Hagen Vorhalle | |
| 45748 | ma | Em | 09.49 | Brvalo | 10.16 | Brmet | 10.43 | Brgnd | 11.04 | Kfhn | 11.20 | | | Hagen Vorhalle | |
| 45749 | di-za | Kfhz | 03.07 | Brgnd | 03.23 | Brmet | 03.46 | Brvalo | 04.16 | Em | 04.45 | | | Hagen Vorhalle | |
| 45750 | ma-vr | Em | 16.09 | Brvalo | 16.36 | Brmet | 17.03 | Brgnd | 17.24 | Kfhn | 17.42 | | | Hagen Vorhalle | |
| 48975 | za | Sloe | 08.33 | Krg | 09.04 | Rsd | 09.36 | Bd | 09.58 | Ehv | 10.43 | Vl | 11.21/11.45 | Köln Gremberg | |

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Stand: 01-01-19 (versie2019a)

KombiRail EUROPE

| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41701 | ma-vr | Mvtw | 15.11 | Kfhn | 15.55/16.00 | Bd | 16.30 | Tb | 16.47 | Ehv | 17.13 | Vl | 17.51/18.12 | Neuss | | Containers, rijdt* |
| 41706 | ma-vr | Em | 23.09 | Brvalo | 23.36 | Brmet | 00.03 | Brgnd | 00.24 | Kfhn | 00.42/01.06 | Mvtw | 01.50 | Neuss | | Containers, rijdt* |
| 41709 | zo | Mvtw | 10.56 | Kfhn | 11.39/11.43 | Brgnd | 12.00 | Brmet | 12.22 | Brvalo | 12.48 | Em | 13.15 | Neuss | | Containers |
| 41737 | ma-vr | Mvtw | 15.56 | Kfhn | 16.39/16.43 | Brgnd | 17.00 | Brmet | 17.22 | Brvalo | 17.48 | Em | 18.15 | Neuss | | Containers, rijdt niet* |
| 41738 | ma-vr | Em | 21.49 | Brvalo | 22.16 | Brmet | 22.43 | Brgnd | 23.04 | Kfhn | 23.20/23.22 | Mvtw | 00.10 | Neuss | | Containers, rijdt niet* |
| 41741 | ma-vr | Mvtw | 08.46 | Kfhn | 09.31/09.40 | Bd | 10.12 | Tb | 10.29 | Ehv | 11.00 | Vl | 11.45/12.16 | Neuss | | Containers, rijdt* |
| | ma-vr | Mvtw | 10.56 | Kfhn | 11.39/11.53 | Brgnd | 12.10 | Brmet | 12.32 | Brvalo | 12.58 | Em | 13.25 | | | Containers, rijdt niet* |
| 41742 | di,wo,vr | Vl | 12.23/12.51 | Ehv | 13.32 | Tb | 14.02 | Bd | 14.18 | Kfhn | 14.52/14.59 | Mvtw | 15.43 | Neuss | | Containers, rijdt* |
| | do | Vl | 12.23/12.52 | Ehv | 13.32 | Tb | 14.02 | Bd | 14.18 | Kfhn | 14.52/16.10 | Mvtw | 16.54 | | | Containers, rijdt* |
| | di-vr | Em | 11.09 | Brvalo | 11.36 | Brmet | 12.03 | Brgnd | 12.24 | Kfhn | 12.42/12.47 | Mvtw | 13.31 | | | Containers, rijdt niet* |
| 41744 | za | Em | 16.59 | Brvalo | 17.26 | Brmet | 17.53 | Brgnd | 18.14 | Kfhn | 18.32/18.37 | Mvtw | 19.21 | Neuss | | Containers |
| 41759 | di-za | Whz | 04.43 | Kfhn | 04.56/04.59 | Bd | 05.30 | Tb | 05.47 | Ehv | 06.13 | Vl | 06.51/07.20 | Neuss | | Containers, rijdt* |
| | di-za | Whz | 04.42 | Kfhn | 04.456/05.22 | Brmet | 06.02 | Brvalo | 06.28 | Em | 06.55 | | | | | Containers, rijdt niet* |
| 41760 | di-za | Em | 03.59 | Kfhn | 05.32 | | | | | | | | | Duisburg R.-Moerdijk | | Containers |
| 41761 | ma | Kfhn | 20.08 | Bd | 20.42 | Tb | 20.59 | Ehv | 21.30 | Vl | 22.15/22.37 | Kn | 22.48 | Moerdijk-Duisburg R. | | Containers, rijdt* |
| | di-vr | Kfhn | 20.38 | Bd | 21.12 | Tb | 21.29 | Ehv | 22.00 | Vl | 22.45/22.49 | Kn | 23.00 | | | Containers, rijdt* |
| | ma-vr | Kfhn | 21.53 | Brgnd | 22.10 | Brmet | 22.32 | Brvalo | 22.58 | Em | 23.25 | | | | | Containers, rijdt niet* |
| 41764 | ma | Vl | 03.38/03.41 | Ehv | 04.27 | Tb | 04.58 | Bd | 05.15 | Kfhn | 05.48/08.56 | Mvtw | 09.41 | Neuss | | Containers, rijdt* |
| | ma | Em | 03.59 | Kfhn | 05.32/08.56 | Mvtw | 09.41 | | | | | | | | | Containers, rijdt niet* |
| 41772 | ma-vr | Em | 15.49 | Brvalo | 16.16 | Brmet | 16.43 | Brgnd | 17.04 | Kfhn | 17.17/19.32 | Whz | 19.49 | Neuss | | Containers, rijdt* |
| | ma-vr | Em | 17.59 | Brvalo | 18.26 | Brmet | 18.53 | Brgnd | 19.14 | Kfhn | 19.33/19.35 | Whz | 19.49 | | | Containers, rijdt niet* |
| 42507 | zo | Mvtw | 20.06 | Kfhn | 20.49/20.59 | Bd | 21.30 | Tb | 21.47 | Ehv | 22.13 | Vl | 22.52/23.08 | Neuss | | Containers, rijdt* |
| | zo | Mvtw | 20.36 | Kfhn | 21.19/21.23 | Brgnd | 21.40 | Brmet | 22.03 | Brvalo | 22.28 | Em | 22.55 | | | Containers, rijdt niet* |
| 42512 | zo | Em | 17.19 | Brvalo | 17.46 | Brmet | 18.13 | Brgnd | 18.34 | Kfhn | 18.50/18.56 | Mvtw | 19.40 | Neuss | | Containers |

* week 29 t/m week 34

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RAIL R F FEEDING

| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41717 | ma-vr,zo | Mvtw | 23.39 | Whz | 01.03/06.26 | Kfhn | 06.39/06.43 | Brgnd | 07.00 | Brmet | 07.22 | Em | 08.15 | Duisburg-Rheinhausen | Containers |
| 41718 | ma-za | Em | 02.29 | Brmet | 03.23 | Kfhn | 04.00 | Whz | 04.15/09.17 | Bot | 09.30/13.56 | Mvtw | 14.19 | Duisburg-Rheinhausen | Containers |
| 51360 | ma-vr | Mdk | 19.34 | Zlw | 19.59/20.25 | Kfhn | 20.53 | | | | | | | Duisburg Ruhrort | Containers, i.o.v. KRE |
| 51361 | di-za | Kfhn | 06.52 | Zlw | 07.15/07.40 | Mdk | 08.05 | | | | | | | Duisburg Ruhrort | Containers, i.o.v. KRE |

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METRANS

| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42306 | ma | Em | 23.39 | Brvalo | 00.06 | Brmet | 00.33 | Brgnd | 00.54 | Kfhn | 01.13/01.16 | Whz | 01.31 | Ceska Trebova | Containers |
| | do | Em | 23.39 | Brvalo | 00.06 | Brmet | 00.33 | Brgnd | 00.54 | Kfhn | 01.11/05.59 | Whz | 06.14 | | |
| 42307 | vr | Whz | 04.35 | Kfhn | 04.49/06.58 | Brgnd | 07.16 | Brmet | 07.38 | Brvalo | 08.08 | Em | 08.35 | Ceska Trebova | Containers |
| 43304 | ma,wo-vr | Em | 10.59 | Brvalo | 11.26 | Brmet | 11.53 | Brgnd | 12.14 | Kfhn | 12.29 | Whz | 12.44 | Praag | Containers |
| | za | Em | 12.39 | Brvalo | 13.06 | Brmet | 13.33 | Brgnd | 13.54 | Kfhn | 14.12 | Whz | 14.27 | | |
| 43305 | di-vr | Whz | 15.50 | Kfhn | 16.05/16.13 | Brgnd | 16.30 | Brmet | 16.52 | Brvalo | 17.18 | Em | 17.45 | Praag | Containers |
| 43307 | di | Whz | 00.40 | Kfhn | 00.55/01.03 | Brgnd | 01.20 | Brmet | 01.42 | Brvalo | 02.08 | Em | 02.35 | Praag | Containers |
| 43309 | za | Whz | 15.50 | Kfhn | 16.05/16.13 | Brgnd | 16.30 | Brmet | 16.52 | Brvalo | 17.18 | Em | 17.45 | Ceska Trebova | Containers |

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TXLOGISTIK

| Treinnr | Dagen* | Tijden | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41713 | wo | Whz | 04.16 | Kfhn | 04.29/04.38 | Bd | 05.12 | Ehv | 06.00 | Vl | 06.36/06.50 | Kn | 06.58 | München | Containers |
| | vr | Whz | 04.16 | Kfhn | 04.29/04.54 | Bd | 05.32 | Ehv | 06.13 | Vl | 06.48/06.50 | Kn | 06.58 | | |
| 41714 | di,do,za | Kn | 18.34 | Vl | 18.43/19.07 | Ehv | 19.47 | Bd | 20.29 | Kfhn | 20.58/21.01 | Whz | 21.16 | München | Containers |
| 41715 | ma | Whz | 04.50 | Kfhn | 05.05/05.08 | Bd | 05.42 | Ehv | 06.30 | Vl | 07.15/07.20 | Kn | 07.28 | München | Containers |

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Rurtalbahn CARGO

| Treinnr | Dagen* | Tijden | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41529 | di | Mvtw | 04.35 | Kfhn | 05.19/05.30 | Bd | 06.02 | Tb | 06.19 | Ehv | 06.43 | Vl | 07.21/08.20 | Nürnberg | Containers |
| 41530 | di | Vl | 00.54/01.25 | Ehv | 02.06 | Tb | 02.34 | Bd | 02.50 | Kfhn | 03.22/03.31 | Mvtw | 04.16 | Nürnberg | Containers |
| 41534 | wo/do | Vl | 17.39/18.37 | Ehv | 19.17 | Bd | 19.59 | Kfhn | 20.28/20.36 | Mvtw | 21.21/11.29 | Mvtyn | 11.52 | Nürnberg | Containers |
| 41535 | do | Mvtw | 03.47 | Kfhn | 04.32/04.42 | Bd | 05.19 | Tb | 05.33 | Ehv | 05.58 | Vl | 06.34/06.40 | Nürnberg | Containers |
| 41540 | vr | Vl | 17.39/17.52 | Ehv | 18.32 | Bd | 19.18 | Kfhn | 19.52/19.54 | Mvtw | 20.39/21.00 | Mvtyn | 21.23 | Nürnberg | Containers |
| 41541 | zo | Mvtw | 07.45 | Kfhn | 08.29/08.38 | Bd | 09.12 | Tb | 09.29 | Ehv | 10.00 | Vl | 10.45/11.08 | Nürnberg | Containers |
| 41570 | zo | Em | 08.09 | Brvalo | 08.36 | Brmet | 09.03 | Brgnd | 09.24 | Kfhn | 09.42/10.49 | Ps | 11.09 | Frankfurt (Oder) | Containers |
| 41571 | zo | Ps | 18.54 | Kfhn | 19.11/19.13 | Brgnd | 19.30 | Brmet | 19.52 | Brvalo | 20.18 | Em | 20.45 | Frankfurt (Oder) | Containers |
| 41711 | di-za | Ps | 00.02 | Kfhn | 00.19/00.22 | Brgnd | 00.40 | Brmet | 01.02 | Brvalo | 01.28 | Em | 01.55 | Frankfurt (Oder) | Containers |
| 41712 | ma-za | Em | 08.29 | Brvalo | 08.56 | Brmet | 09.23 | Brgnd | 09.44 | Kfhn | 10.02/10.10 | Ps | 10.30 | Frankfurt (Oder) | Containers |
| 41719 | za | Ps | 18.54 | Kfhn | 19.09/19.13 | Brgnd | 19.30 | Brmet | 19.52 | Brvalo | 20.18 | Em | 20.45 | Frankfurt (Oder) | Containers |
| 41723 | di,do,vr,zo | Mvtw | 17.06 | Bot | 17.30 | Kfhn | 17.49/19.43 | Brmet | 20.22 | Brvalo | 20.48 | Em | 21.15 | Duisburg Ruhrort DCT | Containers |
| 41724 | ma,wo,vr,za | Em | 03.49 | Brvalo | 04.16 | Brmet | 04.43 | Kfhn | 05.20/06.15 | Bot | 06.37 | Mvtw | 07.00 | Duisburg Ruhrort DCT | Containers |
| 42304 | do | Kn | 03.18 | Vl | 03.27.03.57 | Rm | 04.23 | Std | 04.50 | Lutdsm | 05.00 | | | Kralupy | Ketels |
| 42305 | di | Lutdsm | 14.20 | Std | 14.28/14.56 | Rm | 15.15 | Vl | 15.44/16.50 | Kn | 17.00 | | | Kralupy | Ketels |
| 42310 | wo,vr | Kn | 06.03 | Vl | 06.11/06.51 | Ehv | 07.32 | Bd | 08.18 | Kfhn | 08.53 | Ps | 09.10 | Well am Rhein | Containers |
| | zo | Kn | 10.02 | Vl | 10.11/20.21 | Ehv | 11.02 | Bd | 11.48 | Kfhn | 12.22/13.05 | Ps | 13.22 | | |
| 42311 | ma,wo,vr | Ps | 13.15 | Kfhn | 13.29/13.38 | Bd | 14.12 | Ehv | 15.00 | Vl | 15.44/16.00 | Kn | 16.08 | Well am Rhein | Containers |
| 42764 | wo,vr | Vl | 05.32/06.06 | Ehv | 06.47 | Bd | 07.29 | Kfhn | 07.58/08.19 | Mvtw | 09.04/09.41 | Mvtyn | 10.03 | Kehl | Containers |
| 42765 | ma,wo | Mvtyn | 21.30 | Mvtw | 21.54/22.46 | Kfhn | 23.29/23.38 | Bd | 00.12 | Ehv | 01.00 | Vl | 01.41/01.43 | Kehl | Containers |
| 42767 | za | Mvtyn | 07.30 | Mvtw | 07.54/13.56 | Kfhn | 14.39/15.00 | Bd | 15.30 | Ehv | 16.13 | Vl | 16.51/16.58 | Kehl | Containers |
| 42768 | zo/ma | Vl | 20.01/20.07 | Ehv | 20.47 | Bd | 21.29 | Kfhn | 21.58/22.06 | Mvtw | 22.52/05.29 | Mvtyn | 05.52 | Kehl | Containers |
| 51400 | di-za | Mvtahw | 02.12 | Mvtw | 02.25/04.16 | Kfhn | 04.59/05.08 | Bd | 05.42 | Ehv | 06.30 | Br | 07.14 | | Containers |
| | zo | Mvtahw | 10.11 | Mvtw | 10.24/14.06 | Kfhn | 14.49/15.00 | Bd | 15.30 | Ehv | 16.13 | Br | 16.50 | | |
| 51401 | ma-do | Br | 10.54 | Ehv | 11.32 | Bd | 12.18 | Kfhn | 12.52/13.06 | Mvtw | 13.51/14.45 | Mvtahw | 14.54 | | Containers |
| | vr | Br | 10.54 | Ehv | 11.32 | Bd | 12.18 | Kfhn | 12.52/13.06 | Mvtw | 13.51/15.01 | Mvtahw | 15.14 | | |
| | za/zo | Br | 10.54 | Ehv | 11.32 | Bd | 12.18 | Kfhn | 12.52/13.06 | Mvtw | 13.51/10.30 | Mvtahw | 10.43 | | |
| 51402 | ma,wo,vr | Mvtaho | 07.40 | Mvtw | 07.46/09.16 | Kfhn | 09.59/10.08 | Bd | 10.42 | Ehv | 11.30 | Br | 12.05 | | Containers |
| | di,do | Mvtyn | 07.08 | Mvtw | 07.46/09.16 | Kfhn | 09.59/10.08 | Bd | 10.42 | Ehv | 11.30 | Br | 12.05 | | |
| 51403 | ma,wo | Br | 15.54 | Ehv | 16.32 | Bd | 17.18 | Kfhn | 17.52/18.36 | Mvtw | 19.21/20.30 | Mvtyn | 20.54 | | Containers |
| | di | Br | 16.39 | Ehv | 17.16 | Bd | 17.59 | Kfhn | 18.28/18.36 | Mvtw | 19.21/20.30 | Mvtyn | 20.54 | | |
| | do | Br | 15.54 | Ehv | 16.32 | Bd | 17.18 | Kfhn | 17.52/17.56 | Mvtw | 18.39/20.30 | Mvtaho | 20.36 | | |
| | vr/za | Br | 15.54 | Ehv | 16.32 | Bd | 17.18 | Kfhn | 17.52/17.56 | Mvtw | 18.39/16.54 | Mvtaho | 17.00 | | |
| 51404 | ma-vr | Mvtw | 15.45 | Kfhn | 16.29/16.38 | Bd | 17.12 | Tb | 17.29 | Ehv | 18.00 | Br | 18.35 | | Containers |
| 51405 | ma-vr | Br | 22.54 | Ehv | 23.32 | Tb | 00.02 | Bd | 00.17 | Kfhn | 00.49/00.55 | Mvtw | 01.40 | | Containers |
| 51406 | ma,wo,vr | Mvtyn | 20.00 | Mvtw | 20.38/21.36 | Kfhn | 22.19/22.30 | Bd | 23.02 | Ehv | 23.43 | Br | 00.21 | | Containers |
| | di,do | Mvtyn | 20.00 | Mvtw | 20.38/21.46 | Kfhn | 22.29/22.38 | Bd | 23.12 | Ehv | 00.00 | Br | 00.38 | | |
| 51407 | di | Br | 03.54 | Ehv | 04.36 | Bd | 05.20 | Kfhn | 05.53/06.16 | Mvtw | 07.01/08.06 | Mvtyn | 08.30 | | Containers |
| | wo | Br | 03.54 | Ehv | 04.36 | Bd | 05.21 | Kfhn | 05.53/06.00 | Mvtw | 06.50/08.06 | Mvtyn | 08.30 | | |
| | do,vr | Br | 04.54 | Ehv | 05.32 | Bd | 06.18 | Kfhn | 06.52/06.56 | Mvtw | 07.40/08.32 | Mvtw | 08.56 | | |
| | vr | Br | 04.56 | Ehv | 05.32 | Bd | 06.18 | Kfhn | 06.52/06.54 | Mvtw | 07.39/08.35 | Mvtyn | 08.56 | | |
| | za | Br | 03.54 | Ehv | 04.36 | Bd | 05.18 | Kfhn | 05.52/06.40 | Mvtw | 07.25/08.06 | Mvtyn | 08.33 | | |
| 51408 | ma | Mvtw | 23.06 | Kfhn | 23.49/00.08 | Bd | 00.42 | Tb | 00.59 | Ehv | 01.29 | Br | 02.14 | | Containers |
| | wo | Mvtw | 21.46 | Kfhn | 22.29/22.38 | Bd | 23.12 | Tb | 23.29 | Ehv | 00.00 | Br | 00.44 | | |
| 51409 | di,do | Br | 06.09 | Ehv | 06.47 | Tb | 07.14 | Bd | 07.29 | Kfhn | 07.58/08.20 | Mvtw | 08.59 | | Containers |
| 51410 | ma | Mvtyn | 10.28 | Mvtw | 10.52 | | | | | | | | | | Containers |
| | wo | Mvtyn | 12.58 | Mvtw | 13.22 | | | | | | | | | | |
| | vr | Mvtyn | 12.58 | Mvtw | 13.22 | | | | | | | | | | |
| 51411 | ma,wo | Mvtw | 17.04 | Mvtyn | 17.27 | | | | | | | | | | Containers |
| 51412 | vr | Mvtw | 23.34 | Mvtyn | 23.57 | | | | | | | | | | Containers |
| 51413 | ma,wo,vr,za | Mvtw | 08.00 | Mvtyn | 08.23 | | | | | | | | | | Containers |
| 51414 | di,do,vr,zo | Mvtyn | 15.36 | Mvtw | 16.00 | | | | | | | | | | Containers |

* Rijdt niet van week 29 t/m week 34

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RAILTRAX

| Treinnr | Dagen* | Tijden | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44523 | di | Esn | 22.26 | Rsd | 22.38/23.06 | Bd | 23.28 | Tb | 23.47 | Ehv | 00.13 | Vl | 00.51/00.58 | Rheinhausen-Antwerpen Kalishoek | Containers |
| 44526 | ma | Vl | 16.11/16.37 | Ehv | 17.17 | Tb | 17.45 | Bd | 18.01/18.29 | Rsd | 18.54/18.59 | Esn | 19.09 | Rheinhausen-Antwerpen Kalishoek | Containers |
| 44563 | do | Esn | 16.36 | Rsd | 16.48/17.34 | Bd | 17.58 | Tb | 18.17 | Ehv | 18.43 | Vl | 19.20/19.28 | Rheinhausen-Antwerpen Kalishoek | Containers |
| 44566 | wo | Vl | 19.11/19.37 | Ehv | 20.17 | Tb | 20.44 | Bd | 20.59 | Rsd | 21.22/21.38 | Esn | 21.46 | Rheinhausen-Antwerpen Kalishoek | Containers |
| 44573 | za | Esn | 14.56 | Rsd | 15.08/15.36 | Bd | 15.58 | Tb | 16.17 | Ehv | 16.43 | Vl | 17.21/17.37 | Rheinhausen-Antwerpen Kalishoek | Containers |
| 44576 | vr | Vl | 13.11/13.37 | Ehv | 14.17 | Tb | 14.45 | Bd | 15.00 | Rsd | 15.26/15.28 | Esn | 15.39 | Rheinhausen-Antwerpen Kalishoek | Containers |

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RAIL FORCE ONE

| Treinnr | Dagen* | Tijden | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46266 | ma,wo,vr | Bh | 12.36 | Odz | 12.49/15.46 | Aml | 16.09 | Dv | 16.37 | Amf | 17.21/17.43 | Wp | 18.14 | Kolin/Trnava-Zeebrugge | Auto's |
| | | Gd | 18.58 | Rtd | 19.22/19.25 | Kfh | 19.44 | | | | | | | | |
| 46267 | ma,vr | Kfh | 08.14 | Rtng | 08.38/08.48 | Wd | 09.14 | Wp | 09.46 | Amf | 10.15 | Sto | 10.32/10.51 | Zeebrugge-Kolin/Trnava | (Leeg) auto's |
| | | Dv | 11.23 | Aml | 11.50 | Odz | 12.13/14.00 | Bh | 14.15 | | | | | | |
| | wo | Kfh | 09.00 | Gd | 09.33 | Wp | 10.16 | Amf | 10.45 | Sto | 11.02/11.11 | Dv | 11.39 | | |
| | | Aml | 12.15 | Odz | 12.36/14.00 | Bh | 14.15 | | | | | | | | |
| 46268 | di,do,zo | Bh | 12.36 | Odz | 12.49/15.46 | Aml | 16.09 | Dv | 16.37 | Amf | 17.21/17.43 | Wp | 18.14 | Kolin/Trnava-Zeebrugge | Auto's |
| | | Gd | 18.58 | Rtd | 19.22/19.25 | Kfh | 19.44 | | | | | | | | |
| 46269 | di,do | Kfh | 08.14 | Rtng | 08.38/08.48 | Wd | 09.14 | Wp | 09.46 | Amf | 10.15 | Sto | 10.32/10.51 | Zeebrugge-Kolin/Trnava | (Leeg) auto's |
| | | Dv | 11.23 | Aml | 11.50 | Odz | 12.13/14.00 | Bh | 14.15 | | | | | | |
| | zo | Kfh | 08.00 | Gd | 08.36 | Wp | 09.16 | Amf | 09.45 | Sto | 10.02/10.07 | Dv | 10.39 | | |
| | | Aml | 11.14 | Odz | 11.38/14.00 | Bh | 14.15 | | | | | | | | |
| 49798 | di,vr | Mvtww | 02.46 | Kfhn | 03.29/03.33 | Brgnd | 03.50 | Brmet | 04.12 | Brvalo | 04.38 | Em | 05.05 | Neuss | Containers |
| 49799 | di,vr | Em | 21.19 | Brvalo | 21.46 | Brmet | 22.13 | Brgnd | 22.34 | Kfh | 22.50 | Mvtww | 23.35 | Neuss | Containers |
| 63113 | di,do | Amf | 11.13 | Amfpon | 11.25 | | | | | | | | | | Auto's i.o.v. DBC |
| 63114 | di,do | Amfpon | 17.02 | Amf | 17.20 | | | | | | | | | | Leeg auto's i.o.v. DBC |
| 63123 | ma,wo,vr | Amfpon | 17.01 | Amf | 17.20 | | | | | | | | | | Leeg auto's i.o.v. DBC |
| 63124 | ma,wo,vr | Amf | 10.43 | Amfpon | 10.55 | | | | | | | | | | Auto's i.o.v. DBC |

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DB LINEAS

| Treinnr | Dagen* | Tijden | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41600 | ma-vr | Fsz | 09.37 | Svg | 09.47/09.50 | Slua | 10.11 | Sludow | 10.26 | | | Antwerpen Combinant | Lineas, containers |
| 41601 | ma-vr | Sludow | 17.56 | Slua | 18.11 | Svg | 18.32/18.35 | Fsz | 18.45 | | | Antwerpen Combinant | Lineas, containers |
| 44606 | ma,wo,vr | Fsz | 07.21 | Svg | 07.32 | | | | | | | Gent Zeehaven | |
| | di,do | Fsz | 07.11 | Svg | 07.11 | | | | | | | | |
| 44607 | ma-vr | Svg | 17.36 | Fsz | 17.51 | | | | | | | Gent Zeehaven | wagens voor trein 44602 |
| 44608 | ma-vr | Fsz | 17.03 | Svg | 17.13 | | | | | | | Gent Zeehaven | |
| 44622 | ma-vr | Fsz | 09.48 | Svg | 09.58/10.11 | Slua | 10.32 | Sludow | 10.57 | | | Antwerpen Noord | Afhaken wgs Yara in Svg |
| 44623 | ma-vr | Sludow | 12.19 | Slua | 12.34/12.56 | Svg | 13.17/13.57 | Fsz | 14.07 | | | Antwerpen Noord | Aanhaken wgs Yara in Svg |
| 44611 | ma-vr | Svg | 11.45 | Fsz | 12.00 | | | | | | | Gent Zeehaven | Wagens voor trein 44602 |
| 47608 | ma-vr | Fsz | 13.16 | Svg | 12.26/12.31 | Slua | 12.51/12.54 | Sludow | 13.03 | | | Schkopau/Buna | Wagens van trein 48570, wo FZ |
| 47609 | ma-za | Sludow | 13.52 | Slua | 14.02 | Svg | 14.22/14.26 | Fsz | 14.33 | | | Schkopau/Buna | Wagens voor trein 48571, wo FZ |
| 47620 | ma | Fsz | 07.56 | Svg | 08.05/08.09 | Slua | 08.30 | Tnzz | 08.40/09.07 | Axa | 09.17 | Saint-Ghislain | FM, Lineas, bediening Yara |
| 47621 | ma | Axa | 10.56 | Tnzz | 11.06/11.25 | Slua | 11.35 | Svg | 11.56/12.01 | Fsz | 12.11 | Saint-Ghislain | FM, Lineas, bediening Yara |
| 48577 | do | Tnzz | 19.50 | Slua | 20.00 | Svg | 20.21/20.50 | Fsz | 21.00 | | | Garching (Alz) | FM, kolen |
| 48578 | wo | Fsz | 18.52 | Svg | 19.03/19.10 | Slua | 19.30 | Tnzz | 19.35 | | | Garching (Alz) | FM, leeg kolen |
| 62770 | ma-vr | Svg | 07.46 | Slua | 08.06 | Tnzz | 08.11/08.31 | Axa | 08.41 | | | | |
| 62771 | ma-vr | Axa | 09.20 | Tnzz | 09.30/11.05 | Slua | 11.15 | Svg | 11.30 | | | | |
| 62772 | ma-vr | Svg | 09.00 | Slua | 09.20 | Tnzz | 09.25/09.45 | Axa | 09.55 | | | | |
| 62773 | ma-vr | Axa | 13.05 | Tnzz | 13.15/15.10 | Slua | 15.15 | Svg | 15.35 | | | | Afvoer Outokumpu |
| 62774 | ma-vr | Svg | 13.21 | Slua | 13.41 | Tnzz | 13.46 | | | | | | |
| 62777 | ma-vr | Axa | 15.40 | Tnzz | 15.50/16.10 | Slua | 16.15 | Svg | 16.35 | | | | Afvoer Outokumpu |
| 62778 | ma-vr | Svg | 08.25 | Slua | 08.45/08.52 | Sludow | 09.06 | | | | | | Wagens van trein 44606 |
| 62779 | ma-vr | Sludow | 10.15 | Slua | 10.24/10.35 | Svg | 10.55 | | | | | | Wagens voor trein 44611 |

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Stand: 01-01-19 (versie2019a)

RheinCargo

| Treinnr | Dagen* | Tijden | | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41702 | ma | Em | 19.39 | Brvalo | 20.06 | Brmet | 20.33 | Kfhz | 21.09/21.33 | Mvtw | 22.18/23.27 | Mvtahw | 23.40 | Köln Niehl-Hafen | Containers |
| 41703 | di | Mvtahw | 23.35 | Mvtw | 23.48/00.06 | Kfhn | 00.49/00.53 | Brmet | 01.32 | Brvalo | 01.58 | Em | 02.25 | Köln Niehl-Hafen | Containers* |
| 41704 | wo,vr | Em | 22.39 | Brvalo | 23.06 | Brmet | 23.33 | Kfhn | 00.12/02.03 | Mvtw | 02.46/03.33 | Mvtyn | 03.50 | Köln Niehl-Hafen | Containers* |
| 41705 | do | Mvtyn | 21.20 | Mvtw | 21.44/21.57 | Kfhn | 22.39/22.53 | Brmet | 23.32 | Brvalo | 23.58 | Em | 00.25 | Köln Niehl-Hafen | Containers |
| 41730 | vr | Em | 02.19 | Brvalo | 02.46 | Brmet | 03.13 | Kfhn | 03.50/04.15 | Mvtw | 04.58/05.34 | Mvtaho | 05.39 | Köln N-H/Düsseldorf H. | Containers* |
| 41731 | ma | Mvtaho | 20.40 | Mvtw | 20.47/20.56 | Kfhn | 21.39/22.53 | Brmet | 23.32 | Brvalo | 23.58 | Em | 00.25 | Köln N-H/Düsseldorf H. | Containers |
| 41733 | za/zo | Mvtyn | 21.26 | Mvtw | 21.50/18.06 | Kfhn | 18.48/18.53 | Brmet | 19.32 | Brvalo | 19.58 | Em | 20.25 | Düsseldorf Hafen | Containers* |
| 41734 | di,za | Em | 02.19 | Brvalo | 02.46 | Brmet | 03.13 | Kfhn | 03.52/04.20 | Mvtw | 05.03/06.03 | Mvtyn | 06.26 | Düsseldorf Hafen | Containers |
| 41735 | di | Mvtyn | 21.50 | Mvtw | 21.54/23.46 | Kfhn | 00.29/00.43 | Brmet | 01.22 | Brvalo | 01.48 | Em | 02.15 | Düsseldorf Hafen | Containers |
| 41775 | za/zo | Mvtahw | 19.10 | Mvtw | 19.22/20.26 | Kfhn | 21.09/09.13 | Brmet | 09.52 | Brvalo | 10.18 | Em | 10.45 | Köln Niehl-Hafen | Containers* |
| 41778 | do | Em | 02.19 | Brvalo | 02.46 | Brmet | 03.13 | Kfhn | 03.52/04.20 | Mvtw | 05.03 | | | Düsseldorf Hafen | Containers* |
| 42620 | wo | Bh | 01.35 | Aml | 02.12 | Dv | 02.48 | Zlr | 03.20/03.53 | On | 05.14 | Vdma | 05.45 | Basel | FM, Bauer-containers** |
| 42622 | wo/do | Bh | 23.53 | Aml | 00.30 | Dv | 00.56 | Zlr | 01.22/03.31 | Onz | 05.03 | Vdma | 05.31 | Basel | FM, Bauer-containers** |
| 42623 | ma | Hde | 21.43 | Zl | 22.02 | Dv | 22.40 | Bh | 23.51 | | | | | Basel | FM, Bauer-containers** |
| 42624 | za | Bh | 00.44 | Aml | 01.21 | Dv | 01.53 | Zlr | 02.23/03.03 | Onz | 04.28 | Vdma | 04.57 | Basel | FM, Bauer-containers** |
| 42625 | wo | Hde | 21.43 | Zl | 22.02 | Dv | 22.40 | Bh | 23.51 | | | | | Basel | FM, Bauer-containers** |
| 42626 | zo | Bh | 13.57 | Aml | 14.39 | Dv | 15.21 | Zl | 15.48/15.56 | Hde | 16.18 | | | Basel | FM, Bauer-containers** |
| 42627 | do | Hde | 21.41 | Zl | 22.02 | Dv | 22.40 | Bh | 23.51 | | | | | Basel | FM, Bauer-containers** |
| 42629 | za | Hde | 21.37 | Zl | 22.02 | Dv | 22.40 | Bh | 23.51 | | | | | Basel | FM, Bauer-containers** |
| 42717 | do/vr | Mvtw | 23.30 | Kfhn | 00.49/01.03 | Brmet | 01.42 | Brvalo | 02.08 | Em | 02.35 | | | Düsseldorf Hafen | Containers |
| 42719 | wo | Mvtaho | 21.30 | Mvtw | 21.37/22.57 | Kfhn | 23.39/23.53 | Brmet | 00.32 | Brvalo | 00.58 | Em | 01.25 | Köln Niehl-Hafen | Containers |
| 42721 | wo | Em | 02.19 | Brvalo | 02.46 | Brmet | 03.13 | Kfhn | 03.50/04.15 | Mvtw | 04.58/05.34 | Mvtaho | 05.39 | Köln Niehl-Hafen | Containers* |
| 50901 | ma,wo,do,za | Vdma | 18.47 | On | 19.10 | Hgv | 19.47/19.55 | Zl | 20.30 | Hde | 20.45 | | | Basel | FM, Bauer-containers** |
| 50902 | zo | Hde | 17.07 | Zl | 17.27 | Bl | 18.14/18.19 | On | 18.51/18.59 | Vdma | 19.25 | | | Basel | FM, Bauer-containers** |

* Rijdt niet van week 29 t/m week 34; ** Van week 4 t/m week 17 en week 40 t/m week 49

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Stand: 01-01-2019 (versie2019a)

SBB Cargo International

| Treinnr | Dagen* | Tijden | | | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40030 | di-vr | Em | 22.09 | Brvalo | 22.36 | Brmet | 23.03 | Brgnd | 23.24 | Kfhn | 23.42/23.49 | Whz | 00.03 | Melzo | Containers* |
| | za/zo | Em | 22.09 | Brvalo | 22.36 | Brmet | 23.03 | Brgnd | 23.24 | Kfhn | 23.42/11.41 | Whz | 11.56 | | |
| 40031 | ma-vr | Whz | 22.20 | Kfhn | 22.35/22.38 | Brgnd | 22.55 | Brmet | 23.17 | Brvalo | 23.43 | Em | 00.10 | Melzo | Containers |
| 40032 | zo | Em | 19.19 | Brvalo | 19.46 | Brmet | 20.13 | Brgnd | 20.34 | Kfhn | 20.52/21.15 | Whz | 21.27 | Melzo | Containers* |
| 40035 | za | Whz | 22.00 | Kfhn | 22.16/22.38 | Bd | 23.12 | Tb | 23.29 | Ehv | 00.00 | Vl | 00.45/00.49 | Melzo | Containers |
| 40036 | ma | Em | 22.09 | Brvalo | 22.36 | Brmet | 23.03 | Brgnd | 23.25 | Kfhn | 23.42/23.58 | Whz | 00.12 | Melzo | Containers |
| 40037 | zo | Whz | 22.13 | Kfhn | 22.27/22.30 | Bd | 23.02 | Tb | 23.17 | Ehv | 23.43 | Vl | 00.21/00.30 | Melzo | Containers |
| 40118 | wo-vr | Em | 13.29 | Brvalo | 13.56 | Brmet | 14.23 | Brgnd | 14.44 | Kfhn | 15.00/15.05 | Bot | 15.28 | Milano Smistamento | Containers* |
| | za | Em | 13.29 | Brvalo | 13.56 | Brmet | 14.23 | Brgnd | 14.44 | Kfhn | 15.02/15.19 | Bot | 15.41 | | |
| 40119 | di-vr | Bot | 19.38 | Kfhz | 19.59/20.03 | Brgnd | 20.20 | Brmet | 20.42 | Brvalo | 21.08 | Em | 21.35 | Milano Smistamento | Containers |
| 40120 | zo | Em | 10.59 | Brvalo | 11.26 | Brmet | 11.53 | Brgnd | 12.14 | Kfhn | 12.32/12.37 | Bot | 13.00 | Milano Smistamento | Containers |
| 40121 | za | Bot | 22.07 | Kfhn | 22.29/22.31 | Bd | 23.02 | Tb | 23.17 | Ehv | 23.43 | Vl | 00.21/00.29 | Milano Smistamento | Containers |
| 40137 | ma-do | Whz | 18.30 | Kfhn | 18.45/18.53 | Brgnd | 19.10 | Brmet | 19.32 | Brvalo | 19.58 | Em | 20.25 | Busto Arsizio | Containers |
| 40152 | zo | Em | 22.39 | Brvalo | 23.06 | Brmet | 23.33 | Brgnd | 23.54 | Kfhn | 00.12/00.19 | Whz | 00.33 | Busto Arsizio | Containers |
| 40153 | zo | Whz | 11.50 | Kfhz | 12.06/12.17 | Brgnd | 12.30 | Brmet | 12.52 | Brvalo | 13.18 | Em | 13.45 | Busto Arsizio | Containers |
| 40160 | zo | Em | 09.09 | Brvalo | 09.36 | Brmet | 10.03 | Brgnd | 10.24 | Kfhn | 10.40/20.04 | Whz | 20.18 | Busto Arsizio | Containers* |
| 40161 | za | Whz | 00.01 | Kfhn | 00.15/02.43 | Brgnd | 03.00 | Brmet | 03.22 | Brvalo | 03.48 | Em | 04.15 | Busto Arsizio | Containers |
| 40200 | wo,do | Em | 09.09 | Brvalo | 09.36 | Brmet | 10.03 | Brgnd | 10.24 | Kfhn | 10.42/10.49 | Whz | 11.03 | Busto Arsizio | Containers* |
| | vr | Em | 09.09 | Brvalo | 09.36 | Brmet | 10.03 | Brgnd | 10.24 | Kfhn | 10.42/14.09 | Whz | 14.23 | | |
| | za | Em | 09.09 | Brvalo | 09.36 | Brmet | 10.03 | Brgnd | 10.24 | Kfhn | 10.42/12.21 | Whz | 12.35 | | |
| 40201 | di-vr | Whz | 01.50 | Kfhn | 02.05/02.13 | Brgnd | 02.30 | Brmet | 02.52 | Brvalo | 03.18 | Em | 03.45 | Busto Arsizio | Containers* |
| 40203 | zo | Whz | 18.40 | Kfhn | 18.55/19.03 | Brgnd | 19.20 | Brmet | 19.42 | Brvalo | 20.08 | Em | 20.35 | Busto Arsizio | Containers |
| 40204 | ma | Em | 09.29 | Brvalo | 09.56 | Brmet | 10.23 | Brgnd | 10.44 | Kfhn | 11.02/11.09 | Whz | 11.24 | Busto Arsizio | Containers |
| 40205 | vr | Whz | 20.40 | Kfhn | 20.55/21.03 | Brgnd | 21.20 | Brmet | 21.42 | Brvalo | 22.08 | Em | 22.35 | Busto Arsizio | Containers |
| 40220 | wo-za | Em | 03.29 | Brvalo | 03.56 | Brmet | 04.23 | Brgnd | 04.44 | Kfhn | 05.02/05.06 | Whz | 05.18 | Mortara | Containers* |
| 40221 | di-vr | Whz | 00.01 | Kfhn | 00.16/00.32 | Brgnd | 00.50 | Brmet | 01.12 | Brvalo | 01.38 | Em | 02.05 | Mortara | Containers |
| 40223 | za | Whz | 06.10 | Kfhn | 06.25/10.53 | Brgnd | 11.10 | Brmet | 11.32 | Brvalo | 11.58 | Em | 12.25 | Mortara | Containers |
| 40224 | zo | Em | 19.09 | Brvalo | 19.36 | Brmet | 20.03 | Brgnd | 20.24 | Kfhn | 20.42/20.47 | Whz | 20.59 | Mortara | Containers |
| 41750 | ma-zo | Vl | 09.53/10.07 | Ehv | 10.47 | Tb | 11.14 | Bd | 11.29 | Kfhn | 11.59/12.02 | Erp | 12.34 | Novara | Containers |
| 41751 | ma,di,do,vr | Erp | 20.58 | Kfhn | 21.29/21.38 | Bd | 22.12 | Tb | 22.29 | Ehv | 23.00 | Vl | 23.45/00.07 | Novara | Containers |
| | wo | Erp | 21.08 | Kfhn | 21.39/22.00 | Bd | 22.30 | Tb | 22.47 | Ehv | 23.13 | Vl | 23.49/00.07 | Novara | Containers |
| 41763 | za,zo | Erp | 21.38 | Kfhn | 22.09/22.13 | Brgnd | 22.29 | Brmet | 22.52 | Brvalo | 23.18 | Em | 23.45 | Novara | Containers |
| 43674 | wo-za | Em | 01.19 | Brvalo | 01.46 | Brmet | 02.13 | Brgnd | 02.34 | Kfhn | 02.52/03.06 | Whz | 03.20 | Busto Arsizio | Containers* |
| 43712 | zo | Vl | 07.39/07.52 | Ehv | 08.32 | Tb | 09.02 | Bd | 09.18 | Kfhn | 09.52/11.09 | Whz | 11.23 | Busto Arsizio | Containers |
| 47053 | do | Bot | 16.28 | Kfhz | 16.49/16.53 | Brgnd | 17.10 | Brmet | 17.32 | Brvalo | 17.58 | Em | 18.25 | Safenwil | Auto's* |
| 47060 | di | Em | 17.19 | Brvalo | 17.46 | Brmet | 18.13 | Brgnd | 18.34 | Kfhz | 18.49/18.54 | Bot | 19.18 | Safenwil | Leeg auto's* |

* Rijdt niet van week 29 t/m week 34

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Stand: 01-01-19 (versie2019a)

| Treinnr | Dagen* | Tijden | | * Vermelde dagen zijn vertrekdagen vanaf eerstgenoemde plaats | | | | | | | | | | Van/Naar | Opmerkingen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41350 | di-vr,zo | Em | 22.29 | Brvalo | 22.56 | Brmet | 23.23 | Brgnd | 23.44 | Kfhn | 00.03/00.14 | Erp | 00.46 | Poznan (Swarzedz) | Containers* |
| 41351 | ma-wo,vr,zo | Erp | 22.38 | Kfhn | 23.09/23.13 | Brgnd | 23.30 | Brmet | 23.52 | Brvalo | 00.18 | Em | 00.45 | Poznan (Swarzedz) | Containers |
| 41966 | za | Vl | 12.22/12.37 | Ehv | 13.17 | Tb | 13.44 | Bd | 13.59 | Kfhn | 14.28 | Mvtw | 15.08 | Linz | Containers |
| 41967 | zo | Whz | 21.20 | Kfhn | 21.35/21.38 | Bd | 22.12 | Tb | 22.29 | Ehv | 23.00 | Vl | 23.45/00.05 | Linz | Containers |
| 41968 | wo | Vl | 03.41/04.09 | Ehv | 04.54 | Tb | 05.22 | Bd | 05.36 | Kfhn | 06.07/06.56 | Mvtw | 07.38 | Linz | Containers |
| 41969 | do | Whz | 05.20 | Kfhn | 05.31/05.38 | Bd | 06.12 | Tb | 06.29 | Ehv | 07.00 | Vl | 07.45/08.20 | Linz | Containers |
| 41970 | wo | Vl | 02.37/02.53 | Ehv | 03.36 | Tb | 04.07 | Bd | 04.24 | Kfhn | 04.55/05.34 | Mvtww | 06.20 | Wolfurt | Containers |
| 41971 | ma | Mvtw | 17.27 | Kfhn | 18.09/18.30 | Bd | 19.02 | Tb | 19.17 | Ehv | 19.43 | Vl | 20.21/20.29 | Wolfurt | Containers |
| 41972 | vr | Vl | 07.30/07.37 | Ehv | 08.17 | Tb | 08.44 | Bd | 08.59 | Kfhn | 09.28/09.34 | Mvtww | 10.20 | Wolfurt | Containers |
| 41973 | do | Mvtw | 06.35 | Kfhz | 07.19/07.40 | Bd | 08.12 | Tb | 08.29 | Ehv | 09.00 | Vl | 09.39/09.47 | Wolfurt | Containers |
| 41974 | zo | Vl | 11.11/11.52 | Ehv | 12.32 | Tb | 13.02 | Bd | 13.18 | Kfhn | 13.52/13.58 | Mvtw | 14.44 | Wolfurt | Containers |
| 41975 | za | Mvtw | 11.17 | Kfhn | 11.59/12.08 | Bd | 12.42 | Tb | 12.59 | Ehv | 13.30 | Vl | 14.15/14.17 | Wolfurt | Containers |
| 42324 | wo,vr,zo | Bh | 09.50 | Aml | 10.39 | Dvge | 11.07/11.56 | Zp | 12.16 | Ahb | 12.47/13.07 | Nm | 13.25/13.42 | Rzepin | Containers |
| | | Ht | 14.16 | Tbi | 14.30 | | | | | | | | | | |
| 42325 | ma,wo,vr | Tbi | 21.54 | Nm | 22.47 | Ah | 23.02/23.14 | Dvge | 23.56/00.23 | Aml | 00.50 | Bh | 01.24 | Rzepin | Containers |
| 42350 | za | Em | 14.19 | Brvalo | 14.46 | Brmet | 15.13 | Brgnd | 15.34 | Kfhn | 15.52/15.56 | Erp | 16.28 | Poznan (Swarzedz) | Containers |
| 42351 | do | Erp | 17.38 | Kfhn | 18.09/18.13 | Brgnd | 18.30 | Brmet | 18.52 | Brvalo | 19.18 | Em | 19.45 | Poznan (Swarzedz) | Containers |
| 42708 | di,wo | Vl | 04.30/04.47 | Ehv | 05.32 | Tb | 06.02 | Bd | 06.18 | Kfhn | 06.50 | Whz | 07.03 | Mannheim/Wörth | Containers |
| | do-za | Vl | 04.30/04.37 | Ehv | 05.17 | Tb | 05.44 | Bd | 06.03 | Kfhn | 06.36/06.38 | Whz | 06.51 | | |
| 42753 | ma-vr | Whz | 11.18 | Kfhn | 11.29/11.38 | Bd | 12.12 | Tb | 12.29 | Ehv | 13.00 | Vl | 13.45/14.00 | Mannheim/Wörth | Containers |

* Rijdt niet van week 29 t/m week 34

Disclaimer: Aan deze uitgave kunnen geen enkele rechten worden ontleend en gebruik is geheel op eigen risico.

# Appendix 5: Ethical Clearance Approval

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

**NOTICE OF APPROVAL**

REC: SBER - Initial Application Form

24 July 2019

Project number: 10069

Project Title: Assessing the Costs and Benefits of a Speed Limit for Freight Trains During Night-Time Operations: A Generic Model for the Netherlands

Dear Mr Christopher Bingel

Your REC: SBER - Initial Application Form submitted on 10 May 2019 was reviewed and approved by the REC: Humanities.

Please note the following for your approved submission:

**Ethics approval period:**

| Protocol approval date (Humanities) | Protocol expiration date (Humanities) |
|---|---|
| 24 July 2019 | 23 July 2022 |

**GENERAL COMMENTS:**

**The researcher is reminded to supply the REC with proof of permission from ProRail B.V. as soon as this is available. [ACTION REQUIRED]**

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

**If the researcher deviates in any way from the proposal approved by the REC: Humanities, the researcher must notify the REC of these changes.**

Please use your SU project number (10069) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

**FOR CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD**

Please note that a progress report should be submitted to the Research Ethics Committee: Humanities before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary)

**Included Documents:**

| Document Type | File Name | Date | Version |
|---|---|---|---|
| Proof of permission | letter of consent railistics | 28/03/2019 | 1 |
| Research Protocol/Proposal | Masters_Proposal_CB_final | 18/04/2019 | 1 |
| Budget | study budget | 18/04/2019 | 1 |
| Recruitment material | Interview request_EN | 18/04/2019 | 1 |
| Informed Consent Form | SU HUMANITIES Consent form template_CB | 18/04/2019 | 1 |
| Data collection tool | questionnaires_all | 07/05/2019 | 1 |
| Default | Confidentiality clause ProRail | 10/05/2019 | 1 |
| Default | pbe00006_inkoopvoorwaarden_prorail_b.v | 10/05/2019 | 1 |
| Request for permission | Gatekeeper Permission ProRail | 10/05/2019 | 2 |
| Data collection tool | Interview protocol | 10/05/2019 | 1 |

If you have any questions or need further help, please contact the REC office at cgraham@sun.ac.za.

Sincerely,

Clarissa Graham

REC Coordinator: Research Ethics Committee: Human Research (Humanities)

*National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.*
*The Research Ethics Committee: Humanities complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.*

## Appendix 6: Letter of Consent by ProRail B.V.

ProRail

**Memo**

| | | | |
|---|---|---|---|
| Aan | Christopher Bingel | Van | Jack Kruijer |
| Datum | 3 juli 2019 | Telefoonnummer | +31 -631665025 |
| Uw kenmerk | | Status | |
| Ons kenmerk/ID | - | Eigenaar | Jack Kruijer |
| Bijlage(n) | | | |
| Onderwerp | Master thesis | | |

*Dear Mr. Bingel,*

*ProRail B.V. has commissioned a study to investigate the economic effects of differentiated driving of freight trains during the night in the Netherlands.*

*This letter is to certify that Railistics GmbH has been awarded the contract and that all relevant information provided by ProRail B.V. may be used within the scope of this study.*
*Furthermore, we confirm that Mr Christopher Bingel, working on the project on behalf of Railistics GmbH, may use these information to compile a master's thesis on the subject at the University of Stellenbosch.*

*Kind regards,*

**Jack Kruijer** | Programmamanager | Vervoer en Dienstregeling, VACO
06 31 66 50 25 | www.prorail.nl
De Inktpot B1 , Moreelsepark 3, 3511 EP Utrecht | Postbus 2038, 3500 GA Utrecht

# Appendix 7: Letter of Consent by Railistics GmbH

railistics

Railistics | Bahnhofstr. 36 | 65185 Wiesbaden | Germany

To
The Research Ethics Committee: Humanities
Stellenbosch University

Date: 28th March 2019

**Usage Permission for Railistics Database**

Dear Sir or Madam,

this is to confirm that Mr Christopher Bingel is working for Railistics GmbH on the Project "Differentiated Driving" regarding the economic evaluation of a speed limit reduction for freight trains in the Netherlands. He may use any data in Railistic's in-house database for the purpose of this study and his master's thesis at Stellenbosch University.

With best regards

Railistics GmbH

Udo Sauerbrey

Managing Director

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