"Promoting inland waterway transport as part of future sustainable transport solutions"

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<td>Roll on Roll off</td>
</tr>
<tr>
<td>GMS</td>
<td>Großmotorschiff</td>
</tr>
<tr>
<td>üGMS</td>
<td>Übergroßes Motorschiff</td>
</tr>
<tr>
<td>FTIP</td>
<td>Federal Transport Infrastructure Plan</td>
</tr>
<tr>
<td>SOx</td>
<td>Sulphur Oxides</td>
</tr>
<tr>
<td>NOx</td>
<td>Nitrogen oxides</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate matter</td>
</tr>
<tr>
<td>Tkm</td>
<td>Tonne-kilometre</td>
</tr>
<tr>
<td>Vkm</td>
<td>Vehicle-kilometre</td>
</tr>
<tr>
<td>N₂O</td>
<td>Nitrous oxide</td>
</tr>
<tr>
<td>CH₄</td>
<td>Methane</td>
</tr>
<tr>
<td>HGV</td>
<td>Truck</td>
</tr>
<tr>
<td>bn</td>
<td>Billion</td>
</tr>
<tr>
<td>SWOT</td>
<td>Strengths, Weaknesses, Opportunities, Threats</td>
</tr>
<tr>
<td>ADAC</td>
<td>Allgemeine Deutsche Automobil-Club e. V.</td>
</tr>
<tr>
<td>JIT</td>
<td>Just-in-Time</td>
</tr>
<tr>
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1. Introduction

Nowadays sustainable and thus also climate friendly transport solutions become more and more important, due to the climate change. On 12th December 2015 197 nations signed the Paris Agreement which obliges them to take actions to keep “…the global temperature rise this century below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the increase even further to 1.5 degrees Celsius”. The inland transport of goods creates a large part of greenhouse gases because trucks transport most of the commodities. Nevertheless, there are other modes of transport, which are more climate friendly such as inland waterway transportation. That means that inland waterway transportation can play an essential role to reach the climate goals, but there are many challenges which inland waterway transportation has to face to fulfil its role. Due to the fact that sustainability does not only consist of ecological aspects but also of economical and social ones a sustainability study has been carried out to check how sustainable inland waterway transportation is compared to trucking. At the moment inland waterway transportation is underrepresented in the logistics sector.

This scientific paper is the basis for two videos and one website which shall promote inland waterway transportation. As scientific basis this paper presents information and facts about inland waterway transportation to the reader. For that reason, collected facts are shown, a sustainability study as well as a SWOT analysis has been carried out to underline the given information from the videos. The first video will promote inland waterway transportation from the perspective of an inland navigation operator. The second video will represent the point of view from a freight forwarder and will show the viewers why freight forwarders should consider inland waterway transportation as an alternative to trucking. Finally, both videos will be a part of a promoting website. The website will present important information and statements from logistics experts about inland waterway transportation including basic knowledge about the #IWTS 2.0 project, political backgrounds as well as Strength, Weaknesses, Opportunities and Threats of trucking compared to inland waterway transportation. Furthermore, a film library will be part of the website.

The main purpose of this project is to promote inland waterway transportation. The target group consists of young logistics experts which will shape the logistics sector in the next decades. By reaching out to those young logistics experts we want to achieve that those will consider inland waterway transportation stronger as part of the multimodal transport chain. One day those young logistics experts will become the decision makers as a consequence of that they will decide about the consideration of inland waterway transportation in the multimodal transport chain.

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1 Cf. The UNFCCC secretariat (UN Climate Change), https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
2. **What does #IWTS 2.0 mean?**

The project inland waterway transportation solutions or #IWTS2.0 is part of the Interreg North Sea Region program which is supported by the European Regional Development Fund. Main purpose of the Interreg Program is to support development and vivify economic growth. But they are also dealing with topics like the climate change, major and more frequent flooding or how to clean up our environment. To help to archive these goals the Interreg Program want institutions, public administrations and NGO’s to exchange their information and to cooperate.\(^2\)

The total budget of the Interreg Program is 167 million euros and is shared among the four themes which are “Thinking growth”, “Eco-innovation”, “Sustainable North Sea Region” and “Green transport and mobility”. With #IWTS2.0 being a project from the topic “Green transport and mobility” it’s provided with a budget of 3.4 million euro and is planned for a total duration from 1 August 2017 to 30 June 2021.\(^3\)

It is known that the Inland Waterway Transport is relatively slow but it’s also underestimated in many aspects. Especially for cargoes in bulk or large quantities the inland waterway transport offers cheap and climate friendly alternative solutions in the hinterland transport. In whole Europe many waterways are used far under possible capacity.

The #IWTS2.0 Program derives this lack of utilization from different kind of challenges for the inland waterway transportation sector. At first there is only very low awareness about the inland waterway transportation especially for small barge solutions. In addition to that the inland waterway transportation has nearly no innovations in small barge development and in the transhipment of the cargo onto and back from the barge. Furthermore, there is a lack of training content available which leads to problems in the crewing of barges and small waterway vessels.

To tackle these problems the #IWTS2.0 program has laid the focus on some key concepts to mobilize potentials to move cargoes onto underutilized waterways. First of all, the realization of a quick modal shift should be enabled by new and proven logistic technologies backed up by the logistic managers deciding about the transport. In addition to that existing waterways should be adapted to a sufficient standard vesselsize and also small barge concepts should be kept in mind for a better utilization of the waterways. Moreover, the education and training focused on the navigation on smaller waterways should be elaborated. Furthermore, linking the inland waterway transportation to the main Trans-European Networks (TEN-T) highly important to increase the usage of this waterways to make them more attractive to forwarders.

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2 Cf. The North Sea Region Programme Secretariat (About the programme), https://northsearegion.eu/about-the-programme/
3 Cf. The North Sea Region Programme Secretariat (About the project), https://northsearegion.eu/iwts20/about-iwts/
3. Website

3.1. Basics of a website

Before thinking about what a website with the main topics "Promotion of Inland Navigation" and "IWTS 2.0" might look like, some basic points should be explained. At this point it should be said that a successful appearance alone is not sufficient for the creation of a good internet presence. There are different strategies a website can follow.

The most frequently encountered website strategy on the World Wide Web is company representation. It is also often referred to as branding or image site and represents companies, organizations or even projects. No products are to be sold on this type of website. Rather, it is a matter of conveying a good impression to the target group and to potential customers. The strategy of the enterprise representation blurs fluently with that of an information platform. An internet presence that focuses on conveying information as an intention should have a well-developed information architecture. The user should be able to quickly find the information that is important to him. At this point it can be guessed that the internet presence for the project represents a mix of company representation and information platform. The website should inform as far as possible about IWTS 2.0 and at the same time promote inland navigation in Europe with well-founded and scientific information. In addition, numerous video links will be integrated and there will be reports on events on the individual topics. Other website strategies pursue goals such as the sale of products or online auctions where a product can be purchased directly on the called internet presence. At this point, for example, “Amazon” or “eBay” should be named. In addition, there are also e-learning platforms such as “Moodle” which are used for example at “Jade University”. However, there are also internet presences which are designed purely for entertainment.4

The internet presence for the project will be developed in cooperation with “bremenports”, represented by Dr. Stemmler. “bremenports” has already developed a design and defined the basic structure of the website. A freelancer implemented the ideas and wishes with the help of the “Wordpress” software. “Wordpress” is an open source content management system. This means that everyone is allowed to use and change the “Wordpress” software. For this reason, according to the company’s own information, around 20 % of the websites to be called up on the internet are created with “Wordpress”.5 To put it simple, a content management system is a tool with which websites can be easily created and managed. Knowledge of programming languages is almost not necessary. “Wordpress” was initially presented as a tool for creating simple blogs. This has changed significantly in recent years. “Wordpress” has become much more complex thanks to extensive editing options and the option of inserting so-called plug-ins to extend the basic software. Professional internet presences on which also eCommerce can be operated are possible. We have taken advantage of this wealth of possibilities. Under the Domain “www.project-iwts20.eu” a variety of information about inland navigation will be available after the completion of the project. The website is divided into several parts.

5 Cf. WordPress Foundation (Über uns), https://de.wordpress.com/about/
3.2. Website of the project

First of all, the above illustration shows the lead story of the internet presence. This is the first thing a user sees when entering the domain. The start picture shows an inland waterway vessel during loading. It is referred to the Interreg North Sea Region project and the button "Learn more" gives the possibility to get deeper into the topic. If you move further down on the website, quotations from various people in the industry will be displayed. At this point it says from an inland waterway vessel operator (Arne Harms) for example: "I like to compare logistics to a transmission. There are participants who have large and small shares in the system, but only the interaction of all elements makes everything move." The quotations are accompanied by suitable photos to reinforce the statement. If you follow the quotations further down on the website, the user comes to the next category. Under the title "Some basic facts about Inland Waterway Transportation" short articles describing the topic in more detail can be found. For example, the comparison between truck and inland waterway vessel is dealt with here.
After this short overview you can go deeper into the topic. A kind of register refers to single categories which can be opened or closed. In each rubric you will find short, concise texts which refer to videos and explain them briefly. The videos are created on the subject of forwarding agents and inland navigation can be found here. Also integrated at this point is a moving animation which shows the cooperation between the different modes of transport. The aim here is to bring the individual players closer together. Often a combination of several modes of transport is possible. Inland navigation can also play an important role here.

Have you ever wondered how goods arrive on your doorstep?

Figure 3: Animated power point presentation

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8 Cf. bremenports GmbH & Co. KG (Project IWTS 2.0), URL: https://project-iwts20.eu
4. Inland waterway vessel

4.1. Current state of inland navigation

4.1.1. Ship/Fleet

There are currently around 11,500 inland waterway vessels in dry bulk goods transport. A distinction is made between „goods-motor-barges“ and pushed-barges (non-motorised). Around two thirds of these units are registered in the following countries: Belgium, Germany, France, Luxembourg, the Netherlands and Switzerland. The liquid sector comprises some 2,000 inland waterway vessels in Europe. It is even more directed towards the Rhine basin. In the western part of Europe, 86 % of all tankers are registered. By contrast, pusher and tugboat transport is stronger represented at the Danube and in Poland. The Danube region and the third group of countries (Poland, Great Britain, the Czech Republic and Italy) account for a noticeably high share, with around 2,600 tugs and push boats in Europe.9

As in maritime shipping, the types of vessels used in inland navigation have become larger and larger over the last decades, but in order to be able to navigate all the waterways in Europe, different classes of vessels are required. Inland waterway vessels are subdivided into size and type of cargo.

<table>
<thead>
<tr>
<th>Class</th>
<th>Designation</th>
<th>Length in m</th>
<th>Wide in m</th>
<th>Draught in m</th>
<th>Tonnage in t</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>„Spits“</td>
<td>38,50</td>
<td>5,05</td>
<td>1.80 - 2.20</td>
<td>250 - 400</td>
</tr>
<tr>
<td>II</td>
<td>„Kampenaar“</td>
<td>50 - 55</td>
<td>6,60</td>
<td>2,50</td>
<td>400 - 650</td>
</tr>
<tr>
<td>III</td>
<td>„Gustav-Koenig“</td>
<td>60 - 80</td>
<td>8,20 - 9,50</td>
<td>2,50</td>
<td>650 - 1000</td>
</tr>
<tr>
<td>IV</td>
<td>„Europaschiff“</td>
<td>80 - 85</td>
<td>9,50</td>
<td>2,50 - 2,80</td>
<td>1000 - 1500</td>
</tr>
<tr>
<td>Va</td>
<td>„Großmotorschiff“</td>
<td>95 - 110</td>
<td>9,50 - 11,45</td>
<td>2,80 - 3,00</td>
<td>1500 - 3000</td>
</tr>
<tr>
<td>Vb</td>
<td>Pushbarge</td>
<td>172 - 185</td>
<td>11,45</td>
<td>2,50 - 4,50</td>
<td>3200 - 6000</td>
</tr>
<tr>
<td>Vla</td>
<td>Pushbarge</td>
<td>95 - 110</td>
<td>22,90</td>
<td>2,50 - 4,50</td>
<td>3200 - 6000</td>
</tr>
<tr>
<td>Vlb</td>
<td>„Übergroßes Großmotorschiff“</td>
<td>135</td>
<td>17,50</td>
<td>2,50 - 4,50</td>
<td>3000 - 5300</td>
</tr>
<tr>
<td>Vlb (2)</td>
<td>Pushbarge</td>
<td>185 - 195</td>
<td>22,90</td>
<td>2,50 - 4,50</td>
<td>6400 - 12000</td>
</tr>
<tr>
<td>Vlc</td>
<td>Pushbarge</td>
<td>270 - 280</td>
<td>22,90</td>
<td>2,50 - 4,50</td>
<td>9600 - 18000</td>
</tr>
<tr>
<td>Vlc (2)</td>
<td>Pushbarge</td>
<td>195 - 200</td>
<td>33 - 34,35</td>
<td>2,50 - 4,50</td>
<td>9600 - 18000</td>
</tr>
</tbody>
</table>

Table 1: ships are subdivided into classes I-VI according to their dimensions10

Class I-III are mainly found on small rivers or canals. The class IV, the so-called ”Europaschiff”, was designed at the end of the 60s. For many years, its dimensions were decisive for the construction and maintenance of the German lock and canal network.11 After the introduction of the GMS with standard dimensions of 110 m length and 11.45 m width, the locks and canals were adapted accordingly. Since 1997, so-called “üGMS” have been approved for European waterways.12 The standard measurement is 135 m long and 11.45 m wide. One special feature of the vehicle is that the width can vary up to 17,50 m. Whereby these ship types can only operate on the Rhine or NL and Belgium due to the given lock dimensions. Not only the dimensions of the ships play a role, but also the types of cargo.

10 Cf. ShortSeaShipping Inland Waterway Promotion (System der Klassifizierung von Binnenschiffen auf europäischen Binnenwasserstraßen) p. 1.
11 Cf. Interview Arne Harms
12 Cf. PLANCO Consulting GmbH (Entwicklungspotenziale von Güterschiffen über 110m Länge & Bewertung erwogener Ausbaumaßnahmen am Neckar) p. 2.
In figure 4, the inland waterway barge is assigned to the individual cargo types. A inland waterway vessel with an open cargo space can be used very flexibly. Almost anything can be loaded into the hold. From coal, ore to container or heavy-lift cargo. In addition, the hold can be closed with hatches to protect the cargo from getting wet. In inland navigation there are just a few ships that can only be used for container shipping. They have special guide rails in the hold to speed up loading and unloading.

Ships transporting liquid cargos can only be used in this area. Liquid cargos are divided into the category's "N", "C" and "G". Most of these ships carry dangerous cargo. As a result, they are subject to strict regulations during construction and operation. Since the beginning of 2019, there have been no more single-hulled barges in inland navigation. In order to comply with today's type "N" regulations, many single-hulled barges have been converted to double-hulled barges or old type "C" are used as type "N". The cargo of the type "N" are mostly rather harmless goods such as petrol, diesel, oil products, etc. Type "C" transports dangerous chemicals and oil products such as strong acids and alkanes. Type "G" transports liquid gas. This type of ship has three hulls, where the inner hull is a pressure tank.\textsuperscript{13}

4.1.2. Goods

Almost everything is transported on European waterways. The inland waterway vessel is ideal for transporting bulk goods, oils, containers, liquid chemicals and more. Areas such as the steel and energy industries require a large amount of raw materials to operate. A large part of those materials is carried by inland waterway vessels. The disadvantage of longer transport times of inland waterway vessels is compensated by high loading volumes, lower costs and lower emissions.

\textsuperscript{13} Cf. Interview Arne Harms
Figure 5: Goods transported on the Rhine in tonnes compared from 2013-2016

Figure 5 shows the transported goods on the Rhine in the years 2013-2016. Nearly all segments show a decline over the four years. This is due to low water periods. For years, inland navigation, especially on the Rhine, Elbe and Danube, has been struggling with low tide.

In addition, inland vessels are popular for the transport of heavy goods and dangerous goods. Heavy cargo in particular rarely poses a challenge to an inland waterway vessel. For example, in the case of a transformer, a suitable inland vessel can carry an additional partial load. In addition, the transport is not bound to any day or night times as it is usual on the road.

4.1.3. Waterways

Waterways are parts of the water surface which, due to their natural condition, are navigable for shipping or which have been optimised for shipping by structural measures (e.g. dredging or bank reinforcement). A distinction is made between inland waterways and sea waterways.

The European waterway network extends from the North Sea to the Black Sea. In addition, there are trade lanes in Eastern Europe, France, Italy, Great Britain and Portugal. The total length of the European waterway network is around 30,177 km. With 14,362 km (47.6 % of the total length), the Rhine-Danube connection is the longest and most important waterway in Europe.

\[\text{Cf. Sekretariat der Zentralkommission für die Rheinschifffahrt (EUROPÄISCHE BINNENSCHIFFFAHRT MARKTBEOBACHTUNG 2017) p.32.}\]

\[\text{Cf. Sekretariat der Zentralkommission für die Rheinschifffahrt (EUROPÄISCHE BINNENSCHIFFFAHRT MARKTBEOBACHTUNG 2019) p.66.}\]

formance in Europe via the waterway frauded 2016 145 billion tkm. 71 % of this performance went through the waterways of the Netherlands and Germany.17

With a total length of 7.476 km, Germany has the largest continuous waterway network in Europe. In Germany the most important inland waterways are the Rhine and the tributaries Neckar, Main, Mosel and Saar, the Danube and sections of the Weser, Elbe and Oder, as well as the extensive canal network.18 A special feature here is that parts of inland waterways already become inland sea waterways. Inland waterways are divided into two areas, 75 % of which are rivers and 25 % canals. In Germany, the waterway is administered by the Federal Government (Art. 89 II 1 GG). In addition, the waterway will create around 400,000 jobs in Germany.

In order for waterways in Germany to once again do justice to today’s traffic, the Federal Government has launched the Federal Transport Infrastructure Plan 2030 (FTIP 2030). The FTIP 2030 outlines all the investment projects of the individual modes of transport: road, rail and waterways, which will be necessary in the coming years for the further development of a sustainably efficient transport infrastructure. In addition, the BFTIP 2030 shows which further investments are due by the year 2030 for the individual modes of transport, such as the maintenance and replacement of transport networks.19

Projects in the field of waterways were monitored and identified by means of a staged evaluation procedure. When registering projects for the FTIP, federal states, associations and the Federal Waterways and Shipping Administration (WSA) were able to submit project ideas and proposals for the waterway. From these ideas and proposals, the Federal Ministry of Transport and Infrastructure together with the ESC has defined concrete projects. In the staged evaluation procedure, a simplified preliminary investigation was carried out to determine whether the projects could reach the threshold of economic profitability. Some projects for which this could clearly be excluded were excluded from the further evaluation. In the subsequent evaluation stage, the so-called main evaluation was carried out on the basis of the traffic development forecast for 2030 according to the following criteria:20

1. Cost-benefit ratio

2. Affectedness of the environment and nature conservation.

In addition to the evaluation results, the final classification of the projects into the FTIP requirement categories took into account other aspects such as the improvement of the connection of the hinterland to the German seaports.21

From the point of view of transport, the Federal Ministry of Transport and Infrastructure has defined the most important and most heavily used waterways as the core network. In order to ensure that environmentally friendly shipping of goods can be carried out economically and without disruption on these routes, it must be kept functional and efficient. For this reason, expansion measures will be concentrated on these waterways of the core network. The Federal Ministry of Transport and Infrastructure pursues the defined principle that maintenance and replacement investments have priority

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20 Cf. ibid.
21 Cf. ibid.
over expansion and new construction measures. In the secondary network, the Federal Government concentrates above all on measures that are necessary from a safety point of view, such as the maintenance and replacement of weirs.22

German transport policy aims to promote environmentally friendly inland waterway transport. At present, there is a lack of sections of the waterway and of locks over an efficient infrastructure so that inland waterway skippers could be competitive. That is why the federal government is also expanding the infrastructure in places where this investment may not pay off until later. In doing so, the government wants to motivate private investors to invest their money in better vehicles, in the transhipment infrastructure or in logistics concepts in order to make greater use of this infrastructure financed by the federal government.23

The waterway projects were subjected to a full evaluation within the framework of the FTIP and assigned to the requirement categories in the FTIP 2030. Details and results of the evaluation were disclosed. On this basis, the Waterway Expansion Act was then drawn up with the requirements plan for the federal waterways. In the course of the parliamentary consultation on this law, individual additions were made to the requirement plan in comparison with the FTIP 2030.24

As a result of this procedure, 24 projects with a total financial volume of 6.5 billion euros were included in the requirement plan as "New Priority Requirement Projects". The plan also includes 7 projects that have been identified as particularly urgent on the basis of their evaluation results under the title "Urgent needs-bottlenecking".

Ongoing and firmly planned projects:

Total requirement: 1.45 billion euros. Of which new construction/expansion: 931 million euros. Of which maintenance/replacement: 521 million euros.25

- Mittelland Canal, Elbe-Havel Canal, Lower Havel Waterway, Berlin Waterways, Havel Canal: Transport project German Unity No. 17 (VDE 17) Hanover - Magdeburg - Berlin, 250 million euros
- Dortmund-Ems Canal: Expansion of the southern section, 150 million euros
- Mittelweser, partial removal of bottlenecks: Adaptation for the 2.50 metre unloaded large motor vessel (basic variant), 10 million euros plus country financing
- Minden: New lock construction, 3 million euros plus state financing
- Datteln-Hamm Canal: Expansion of the western section, 44 million euros plus state financing
- Rhine-Herne Canal: Expansion east of Gelsenkirchen, 173 million euros plus state financing
- Trier: Construction of the 2nd Moselle lock, 60 million euros (no information given on bottleneck removal)
- Main, partial elimination of bottlenecks: Deepening between Wipfeld and Limbach, 48 million euros
- Niederfinow, partial elimination of bottlenecks: Replacement of ship lift, 56 million euros
- Kiel Canal: Expansion of the eastern section, 260 million euros

23 Cf. Ibid.
24 Cf. Ibid.
New projects - Urgent need and urgent need bottleneck removal:


- Mittelrhein: Optimisation of the unloading of the fairway, 60.2 million euros
- Untermain: deepening of the fairway to Aschaffenburg, 28.3 million euros
- Außenweser: fairway adjustment 62.3 million euros
- Kiel Canal: Deepening, 263.4 million euros
- Unterweser: fairway adjustment (southern route), 5.3 million euros
- Unterweser: fairway adjustment (northern section), 35.4 million euros
- Wesel Dates Channel: Expansion to Marl and replacement of the "large locks", 645.7 million euros
- Außenems: Deepening, 36.7 million euros
- Datteln-Hamm Canal: Expansion of eastern section, 190.5 million euros
- Kiel Canal: Neutralization of the Saatsee curve, 12.4 million euros
- Rostock: Adjustment of seaward port access, 69.3 million euros
- Danube, partial removal of bottlenecks: Extension of Straubing-Vilshofen section (Variant A), 266.5 million euros
- Rhine: Improvement of unloading and sole stabilization between Duisburg and Stürzelberg, 201.3 million euros
- Wismar: Adjustment of seaward port access, 79.1 million euros
- Dortmund-Ems canal, partial removal of bottlenecks: Adjustment of the northern section, 543.3 million euros
- Havel-Oder waterway: expansion, 503 million euros
- Salzgitter branch canal: extension including replacement of two locks, 176.1 million euros
- Coastal canal, partial bottleneck clearance: Extension including replacement of two locks, 254.9 million euros
- Elbe side canal: Early replacement construction of a lock in Lüneburg-Scharnebeck, 270.4 million euros
- Neckar, partial elimination of bottlenecks: lock extension from Mannheim to Plochingen, 1.264 million euros
- Mosel: Construction of seven 2nd lock chambers, 579.3 million euros
- Elbe-Lübeck Canal: Expansion, 838.1 million euros

New projects - further demand:

Total volume: 689.4 million euros. Of which new construction/expansion: 612 million euros. Of which maintenance/replacement: 77.5 million euros.

- Hildesheim branch canal: expansion, 125.6 million euros
- Osnabrück branch canal: replacement construction of two locks, 105.0 million euros
- Saale: Canal construction near Tornitz, 133.8 million euros
- Spree-Oder waterway: Early replacement of three locks, 188.4 million euros
- Teltow Canal: Early replacement of the "Kleinmachnow" lock, 74.4 million euros
- Minden: Replacement of the upper lock, 62.2 million euros

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27 Cf. ibid pp. 172-176.
4.2. Innovations and pilot projects

4.2.1. Beer boat Utrecht

With around 350,000 inhabitants, Utrecht is the fourth largest city in the Netherlands after Rotterdam, Amsterdam and The Hague, and in order to reduce road traffic within the city, the city of Utrecht is trying to use other means of transport. Utrecht has a well-developed canal system. This canal system covers the entire city centre and is connected to the Amsterdam-Rhine Canal. The beer boat in Utrecht offers a successful alternative for sustainable door-to-door delivery in the city centre. The electrically powered boat is 18.8 m long, 4.26 m wide and has a maximum draught of 1.10 m. With a loading capacity of up to 18 tons, the beer boat can load 40-48 roll containers. Heavy loads of up to 14 m can be lifted with a hydraulic crane on board. The energy comes from four 480 volt batteries and lasts for 9 hours. The drive is provided by a 55 kW synchronous motor. In manoeuvring mode, the beer boat still has a 12 kW bow thruster motor in the bow. In Utrecht, the beer boat supplies a total of 65 customers, including four breweries and a gastronomy wholesaler. With a saving of around 16.5 tons of CO2 per year compared to a truck, the beer boat is an environmentally friendly alternative.

4.2.2. Port Feeder Barge Hamburg

The port of Hamburg has a strong problem with air quality for years. The European Commission has therefore obliged the port to improve air quality as quickly as possible in order to comply with the specified limit values. In June 2017, the European Commission presented an air quality plan which shows that about half of the NOx emissions originate from the port. Approx. 1/4 of the total trans-shipment (2 million TEU) is handled within the port, with truck traffic playing a significant role, as NOx emissions are mainly emitted by diesel engines. 0.4 - 1.1 million TEU would be suitable for shifting to water. This would also counteract the shortage of lorry drivers.

Figure 6: Profile view and bird’s eye view Port Feeder Barge

The Port Feeder Barge (PFB) is a free moving platform which is powered by 2x 2 rudder propellers with 280 kW. With a total length of 63.90 m and a width of 21.20 m, the PFB can load 168 TEU. With a large hydraulic crane (e.g. Liebherr CBW 49(39)/27(29) Litronic) a container can weigh 49 t at maximum delivery (27 m). With this radius the whole barge, a landside terminal and a alongside ship can

28 Cf. Gemeente Utrecht (The Beer Boat- All electric supply vessel).
30 Cf. ibid. p. 2.
be loaded and unloaded at the same time. Since the PFB has its own drive and crane, it can be used very flexibly by the respective terminals. During busy periods, the PFB is not dependent on Van-Carrier (VC). It can unload at least 84 TEU at the quay "VC-compatible". In addition, its size allows it to fit between two seagoing vessels.31

The PFB is powered by LNG. Bunkering would be carried out by an LNG tanker. The containers are only loaded on deck, not as on a seagoing vessel. This means that there is sufficient space below deck for storing the LNG without reducing the transport capacity. Emissions are reduced by the LNG drive alone:32

- SOx: -100 %
- NOx: approx. -90 %
- CO2: approx. -20 %
- PM: -100 %

Not only the LNG drive promotes the air quality in the port of Hamburg, but also the decrease in truck round trips would contribute greatly to this. The annual capacity of the PFB is calculated in container units, since the time required for a 20’ container to be installed is the same as for a 40’ container. The operation is calculated at 350 days per year with a handling time of about 14 hours and a realistic crane capacity of about 20 moves/hour, the maximum capacity of the PFB per year amounts to:33

\[ \frac{350 \text{ days/year} \times 14 \text{ hrs/day} \times 20 \text{ moves/hour}}{2 \text{ moves/container}} = 49,000 \text{ containers per year} \]

If this value is multiplied by the TEU factor (1.64) of the Port of Hamburg, it amounts to around 80,000 TEU per year. That would be an average of 140 containers or 228 TEU that could be moved per day. At present, more than 500,000 TEU could be shifted directly to the water. This means that the 6-fold capacity would be directly available. This should ensure sufficient capacity utilization for the PFB.34

5. Forwarding agent

5.1. Actual state of truck traffic

In 2018 350,000 trucks were newly registered into traffic which leads to an overall number of trucks in Germany of about 3.1 million trucks in the end of the year. This and a road network of nearly

31 Cf. Malchow, Ulrich (Eine „Port Feeder Barge“ mit LNG-Antrieb für den Hamburger Hafen) p.3.
32 Cf. Ibit. p. 3.
230,000 km make the road freight transport the most flexible mode of transport in Germany. Also, trucks are not limited to special routes or time schedules.36

The inland waterway transport on the other hand has about 2,100 vessels und a waterway network of 7,476 km available. This shows that the road freight transport is highly better equipped than the inland waterway transport and so is more reliable and flexible.37

![Comparison transport networks](image)

**Figure 7**: Own comparison of the route networks in kilometres

Also, it is possible to react quicker and more customised to transport requests, because trucks do not need a lot of preparation time before being loaded and ready to drive off, plus they do not have to use one route but can avoid traffic jams or other obstacles by using a different street. Another aspect is that trucks can be used for transport of small amounts of freight. An inland waterway vessel can carry up to 3,000 t of cargo, which is equal to 150 trucks, but it is neither economical nor ecological to operate a vessel that carries only half or less of its maximum capacity. So, trucks are more flexible and highly more efficient when it comes to small amounts of freight.38

In addition, there is limited access to the waterway network, which further limits the flexibility of inland waterway transport. Few of the companies have their own inland port or are even located near a waterway, which means that the pre- and post-carrriage to the inland waterway must take place with a second mode of transport. In most cases, this second mode of transport is the lorry, as it can travel almost without restrictions on all roads and can therefore also reach very remote companies.

Loading and unloading trucks rarely requires special equipment other than a truck ramp and a lift truck, whereas inland waterway vessels usually have to be loaded with the help of cranes or conveyor belts. However, the transport of containers plays a special role here, since cranes are always used for handling containers, regardless of the mode of transport used to transport the container.

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This figure shows that most trucks and drivers in Germany are managed and employed by small companies. About 50% of the companies have five or less employees and are family run.

In Germany there are ca. 470,000 truck drivers but the competitors from eastern Europe offer transport for less costs because the wages and taxes are lower.

5.2. Combined transport

The use of containers as cargo units makes combinations of the individual modes of transport very straightforward, as the containers are standardized and handling equipment is available in large quantities. However, semi-trailers can also be transported using several modes of transport. A distinction is made here between the piggyback method and the ro-ro method. In the piggyback method, the semi-trailer is lifted onto a train individually and transported by it. Ro-Ro stands for Roll on Roll off, where the semi-trailer is transported directly onto a ship or, in rare cases, onto a train.
Figure 9: Proportion of combined transport in relation to total transport in 2017

Combined transport accounted for 2.4% of total freight transport in 2017. Of this, 79% is accounted for by combined transport by rail, as the combination of rail and road, and 21% by combined transport by waterways, i.e. the combination of inland waterways and road.

5.3. The future of combined transport on waterways and advantages for freight forwarders as a result

As inland waterway vessels can be used more cheaply over long distances than lorries, it can be advantageous for forwarders to rely on a combination of these two modes of transport. An inland waterway vessel transports a load in one voyage that corresponds approximately to the transport capacity of 100 to 150 lorries. Although an inland waterway vessel is significantly slower than a lorry and therefore takes much longer to transport, a considerable part of the personnel costs is not required since a vessel can be steered by about three to five people. The need for fuel is also much lower. Especially goods that have to be transported in large quantities and are not needed just-in-time can be transported cost-effectively with the help of inland navigation.

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40 Cf. SGKV e.V. – Studiengesellschaft für den Kombinierten Verkehr (Kombinierter Verkehr ) p. 3.
Container transport from seaports to inland ports and into the hinterland is another possible point of contact for inland waterway vessels and freight forwarders, as inland waterway vessels are slowed down by the small network of waterways and trucks are required for delivery to the recipient. The return transport of empty containers also frequently takes place by lorry. Cooperation between barge owners and freight forwarders can lead to competitive advantages here and at the same time bring an advantage for the environment if empty containers do not have to be driven individually, but are collected by lorries and then bundled and transported back to the seaport by inland waterway vessel.

![Figure 10: Development of combined transport volume](image)

The graph shows the development of the volume of goods transported by combined transport in millions of tons, both for combined transport by rail and by waterway. From 2005 to 2017, the volume of goods transported rose from 70 million tons to 111.5 million tons, an increase of 59%. Between 2016 and 2017, the number of TEUs transported in combined transport on waterways increased by 4.8%. Against this background, forwarders should prepare themselves for the increasing importance of combined transport.

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41 Cf. SGKV e.V. – Studiengesellschaft für den Kombinierten Verkehr (Kombinierter Verkehr) p. 4.
6. Sustainability comparison of the individual modes of transport

In 2015 the United Nation published "The 2030 Agenda for Sustainable Development", which was adopted by all United Nations Member States. This document should prompt the countries to develop strategies together in a global partnership and national to improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve the oceans and forests. It includes 17 Sustainable Development Goals (SDGs), which should lead the countries in the right direction for a better future.

![Sustainable Development Goals](image)

Figure 11: United Nations Development Programme

These **17 Sustainable Development Goals** are:

1) End poverty in all its forms everywhere
2) End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3) Ensure healthy lives and promote well-being for all at all ages
4) Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5) Achieve gender equality and empower all women and girls
6) Ensure availability and sustainable management of water and sanitation for all

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42 Cf. Division for Sustainable Development Goals Department of Economic and Social Affairs (Sustainable Development Goals), https://sustainabledevelopment.un.org/?menu=1300
7) Ensure access to affordable, reliable, sustainable and modern energy for all
8) Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9) Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10) Reduce inequality within and among countries
11) Make cities and human settlements inclusive, safe, resilient and sustainable
12) Ensure sustainable consumption and production patterns
13) Take urgent action to combat climate change and its impacts
14) Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15) Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss
16) Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17) Strengthen the means of implementation and revitalise the global partnership for sustainable development

The following chapter is going to obtain three sustainable goals of the 17 SDGs on the current situation of the trucking and inland waterway business. It will be shown what already works according to the 17 SDGs and what needs to be adjusted in order to match the guideline.

The 17 aspects of sustainability are separated into 3 main groups: Ecological, economical and social aspects. This is why one aspect from each category has been chosen for comparison between the trucking and inland waterway transportation business.

In the transport business sustainability plays already an important role and therefore the government tries to adapt multiple aspects out of the SDGs, especially for transportation with a truck. The reason for that is the huge share in the modal split and the problematic situation regarding emissions.

The first point is the 3rd goal of the 17 Sustainable Development Goals, named “Ensure healthy lives and promote well-being for all at all ages”. This point should guide the countries but also organisations to take preventative actions in order to provide a healthy life for everybody and well-being. Most of the time people spend at work, especially long-distance truck drivers, who need to sleep in the truck beside the road. Therefore, it is important especially for organisations to take preventive actions and to protect their employees. Regarding truck drivers, aspects like driving times and rest periods, mental pressure and mobile health care stations are relevant due to sustainability. In Germany, the government established in collaboration with the European Union a law in 2006, which instructs the allowed driving times and rest periods for the driver of a truck. Every organisation and driver have to follow these strict instructions because it will be controlled quite strictly. If the driver cannot meet the requirements, he/she needs to pay a fee, which is instructed in the schedule of

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43 Cf. Division for Sustainable Development Goals Department of Economic and Social Affairs (Sustainable Development Goals), https://sustainabledevelopment.un.org/?menu=1300
fines. If the deviation is too big in most cases the organisation needs also to pay for the infringement. Before the law and sometimes still today organisations blackmail drivers to drive extra hours, because of delays and time pressure. This law should protect the driver and his/her environment in particular regarding mental pressure.

When looking at occupational health care of drivers the government and organisations need to adjust measures. Just 20 % of 256 interviewed German long-distance drivers got occupational health care. This number is very low and the problem is that the employees are always under high pressure due to fear of delays. They are most of the time on the way and they have often no chance to park their truck close to a doctor. Therefore, the project “Doc Stop” was established in order to provide health care for not only truck but also bus drivers etc. If the driver has health problems, he/she can call the hotline of Doc Stop. The hotline provides for the driver the next appropriate parking lot, which is close to the next doctor, who contemporary takes care of him/her. This service extends all over Europe, so everybody has the chance to get appropriate health care anywhere in Europe. This project or service is a good strategy to promote the health and well-being of employees in the trucking business, but it must be made more public, so everybody knows about this service and opportunity. The next point for the health and well-being of drivers is the nightly situations, which is a big problem in Germany. Mostly the drivers of trucks need to sleep in their trucks overnight to meet the rest periods. Particularly in Germany, almost every motorway service area beside the autobahn is overloaded with trucks in the evening till morning. If they found a parking lot within their allowed driving time, sometimes there are no sanitary facilities, which can be used by drivers. Also is it not common to have the possibility to use electricity during their overnight stay. Especially in Germany, the government needs to construct a strategy to offer more and better places, where the driver can stay overnight safe and peacefully.

Boatmen on inland waterway vessels spend around 180 days per year working away from home. Adding to this is the fact that inland waterway vessels are permitted to transport cargo not only from Monday through Saturday but also on Sundays and holidays. In Germany, the “Binnenschiffs-Arbeitszeitverordnung” states that employees in the inland waterway transportation sector are allowed to work on 31 consecutive days. Whilst workers on inland waterway vessels must not work around the clock, the law allows for the employer to extend working hours to 14 hours per day. This also means that boatmen on inland waterway vessels are going to have time off whilst being on board. They not only work, but also live on the waterways for a prolonged period of time, which results in the difficulty of being capable to find a “work-life-balance”. Compared to the trucking business it is a positive effect that sanitary facilities are always available on inland waterway vessels.

A healthy lifestyle can be sustained through obtaining medical check-ups every once in a while. The “Binnenschiffs-Arbeitszeitverordnung” is designed to enable boatmen on inland waterway vessels to get occupational health care, paid by their respective employers, once a year.

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47 Cf. Ibit., p.137.
51 Cf. Ibit.
The second point is the 13th goal: “Take urgent action to combat climate change and its impacts”.
Nowadays the biggest issue in the world is global warming. Without any restrictions on greenhouse gas emissions, the temperature would rise by more than three degrees in the year 2100, which would have terrible dimensions. For this reason, a community of states founded the "Paris Agreement" in 2015, which states the prevention of climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. Germany is also a part of the "Paris Agreement" and hence they established the "Klimaschutzprogramm 2030", which should promote to meet the requirements of the agreement signed in Paris. The main goal is to reduce dangerous greenhouse gas emissions by 55% until 2030. Because of that, the government wants to reduce CO2 emissions in important sectors like energy economics, industry, buildings, transport, agriculture, forestry and so on. Especially the truck is a huge target due to its environmental damage. About 3,200 million tons of cargo are transported by truck every year, who ejects about 103 grams per tkm CO2 emissions. This is ten times as high respectively three times as high as train and inland waterway vessel. For that reason, Germany designed a CO2 tax, which needs to be paid by every party, who produces CO2 emissions. The tax should rise to 350% by the year 2025 and should provide inducements for climate protection in particular in the economy and among consumers. Furthermore, the CO2 tax could lift the price for diesel, so the trucking businesses and forwarders need to focus more on efficiency and environmental awareness. Specifically, alternative transport options like modal traffic or combined traffic would minimise the impact on freight prices. Mainly these arrangements should protect the environment and meet the guidelines of the 17 Sustainable Development Goals.

Inland waterway vessels are one of the most eco-friendly modes of transport. This is the case, because they are able to carry great amounts of cargo using an engine barely larger than that of a truck. In fact, the climate aspect is one of the greatest strongpoints when promoting the inland waterway transportation sector, so it is fair to say that other modes of transport have to do more than inland waterway vessels with respect to emitting greenhouse gases.

In many aspects the inland waterway transportation business is a very traditional mode of transport. So it is not surprising that the average age of an inland waterway vessel in Germany lies at 45.6 years. As stated before, inland waterway vessels emit only few greenhouse gases compared to the trucking business, this does not imply that there is no room for improvement though. Old vessels often mean older engines. Alternative drivetrains are available but not often used as of today. The German government is trying to improve this through its “Förderprogramm nachhaltige Modernisierung von Binnenschiffen”, which is a program pursuing the goal of reducing pollutant-, noise- and greenhouse gas emissions.

The last aspect is the 9th goal, which is named “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”. This goal focus on a resource-efficient, low-pollutant and climate-friendly way of life, specifically in sectors like industry, infrastructure, and innovations. It is important to develop and integrate this mindset, so projects of infrastructures can be

52 Cf. Division for Sustainable Development Goals Department of Economic and Social Affairs (Sustainable Development Goals), https://sustainabledevelopment.un.org/?menu=1300
53 Bundesregierung (Weltweit Klimaschutz umsetzen), https://www.bundesregierung.de/breg-de/themen/nachhaltigkeitspolitik/weltweit-klimaschutz-umsetzen-181812
54 Ibid.
58 Cf. Division for Sustainable Development Goals Department of Economic and Social Affairs (Sustainable Development Goals), https://sustainabledevelopment.un.org/?menu=1300
planned according to the requirements for sustainability. Also, innovations need to focus on the daily relevant questions of topics like sustainable economies, climate and resource protection, energy system transformation, digitalisation, etc.\textsuperscript{59} Regarding the truck, nowadays these above-named question topics are playing a major role in prospective innovations ideas in Germany. Most of the innovations are based on a sustainable mindset and they focus mainly on alternative motors to reduce CO2 emissions. For example, last year in May the organisations “Volkswagen” and “Siemens” established the research project “OL-Lkw”. It is based on hybrid trucks, which should be provided with electricity from an overhead contact line. Therefore, they chose test tracks in the public road traffic like a section of the A1, which have now overhead contact lines. These lines should support the truck until it leaves the autobahn or street and then the truck continues to drive with an electric motor based on a battery. Whether the project can reduce a significant amount of CO2, is now being examined until the end of 2020.\textsuperscript{60} Also, similar projects like “ENUBA” and “ENUBA2” are researching in this field.

Also, more and more truck producers like for example “Scania” try to develop new engines with different fuel options in order to stay competitive in the upcoming trend. At the moment for most of the trucks, diesel is the main fuel, but alternatives such as LNG, CNG, LPG or a hydrogen fuel cell will be researched on efficiency and interoperability.\textsuperscript{61} For example, since the beginning of 2019 Scania is selling trucks, which are operating with LNG. The trucks should have an operating distance of 1000 km for one filling. Especially for short or middle distances is the truck appropriate because the steeple cab is not designed for sleeping.\textsuperscript{62} Whether LNG is the best alternative or not, need to be identified in a short time, so the organisations can transport their cargo on environmentally friendly bases. At the moment on German streets are still almost 3 million trucks, which are operated with diesel. In comparison trucks with alternative engines or engine fuel (electro, liquefied gas, natural gas, and hybrid) are ca. 46,000. That’s about 1.5 % of all the trucks on German streets.\textsuperscript{63} Especially in the section innovations regarding transportation Germany needs to focus more on sustainability. The time is too short, to start researching, so the government and organisations need to present realisable output, which can be used in order to meet the requirements of 17 Sustainable Development Goals.

Europe’s waterways are facing challenges as well. Whilst the “roads” themselves often do not need a lot of repairing or an expansion, the infrastructure connecting or surrounding them often is the problem. Due to being in poor condition, many of the locks in Germany experience downtime on a regular basis. This often causes congestion at these locations, making inland waterway vessels less reliable for their clients and also losing the shipowners time and money. Adding to this is the fact that bridge heights in many locations are restricting inland waterway vessels to only being able to transport containers in stacks of 2 or 3 at best. Finally, ports are also called upon to invest in their respective superstructures. Whilst many inland waterway ports are able to load or discharge cargo of certain kinds, most ports are unable to handle project cargo, which offers great potential for inland waterway vessels.\textsuperscript{64} Adding to this is the calling of inland waterway vessel owners for ports to install power connections ashore. This is also promoted by the German government.\textsuperscript{64}

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{59} Cf. Bundesregierung (Industrie, Innovation und Infrastruktur) https://www.bundesregierung.de/breg-de/themen/nachhaltigkeitspolitik/industrie-innovation-und-infrastruktur-1552930
\item \textsuperscript{60} Cf. Volkswagen (OL-LKW auf öffentlicher Straße, 2018), Pressemitteilung Nr. 172/2018.
\item \textsuperscript{61} Cf. DVZ (LNG-LKW als Klimaretter, 2019), p.6.
\item \textsuperscript{63} Cf. Vortrag Jan-Hendrik Donner (spc), 11.11.2019.
\item \textsuperscript{64} Cf. Bundesministerium für Verkehr und digitale Infrastruktur (Masterplan Binnenschifffahrt), p. 12.
\end{itemize}
\end{footnotesize}
Prolonged hot summers have also become more of a challenge for inland waterway vessels in the recent years. On the river Rhein, inland waterway vessels were forced to transport less than the maximum amount of cargo on 132 days in 2018. If the climate continues to change, further developments in this direction are to be expected. Lastly, the German government is striving to implement the “Bundesverkehrswegeplan 2030”, which aims to offer new jobs at the “Wasser- und Schifffahrtsverwaltung” for the planning and execution of projects.

7. Comparison of cargo types

In the transport industry, there are lots of different kind of cargoes. Goods can be distinguished in weight, nature and dimension. The more specific the cargo, the more difficult it is to transport. Every part of the supply chain has to know how to handle the cargo and what is to do, if something goes wrong. The load securing is one of the most important aspect for a frictionless dispatch. Especially, dangerous goods should be transported with the most suitable mode of transport and well-trained carrier. That kind of cargoes could be either solid cargo, refrigerated cargo or liquid cargo.

In this chapter, there will be discussed two different modes of transportation systems and most of the common cargoes transported by those transportation systems.

7.1. Transported cargoes of German rivers and canals

The diagram gives a short introduction, which cargoes are the most turntables in the inland waterway transportation. Not surprisingly, bulk load is the most important cargo for the inland waterway business. For instance, machines and automotives can interpreted as special cargoes. On the one hand, heavy machines are project cargo, which are non-standardized cargoes. But on the other hand, automotives need a special Roll-On/Roll-Off barge to ensure a fast and easy handling. Remarkably, most of the transported volumes of inland waterway cargoes decreased in the direct comparison between the years 2014 to 2018.

![Figure 12: Cargoes transported by inland waterway vessel in Germany](https://www.sueddeutsche.de/wirtschaft/niedrigwasser-am-rhein-die-pegel-fallen-wieder-1.4542529, tube.ministerium-keit.de/DE/65/87/08/08/8.jpeg)
One reason for this could be the cargo shift from inland waterways to roads. As shown in the figure, the cargo volume, for instance metal ores and other mining and quarrying products fell significantly from approx. 55 million tons in 2014 to approx. 52 million tons in 2018. Another example is the cargo type food products. As shown in the figure, the food products decreased steadily from approximately 9 million tons in 2014 to approximately 7 million tons in 2018. On the other hand, food products increased softly from approx. 300 million tons in 2014 to approx. 330 million tons in 2018. In a nutshell, the inland navigation is not a tremendous player in the transport sector. Nevertheless, inland navigation is able to make the transport sector more sustainable. Furthermore, it is a solution to face current environment aspects and other issues in the future.

7.2. Transported cargoes on road by national vehicles

The following diagram shows the transported volumes, which has been carried by national vehicles in 2014 and 2018. Surprisingly, metal ores and other mining products were the most transported cargoes. At the second place, there are other non-metallic mineral products. Astonishingly, national road vehicles transported a tremendous volume of different kinds of cargoes.

The diagrams show descriptively that the road transportation system is more widely used than the inland waterway transportation system. It is evident that the inland waterway transportation system has its main role in carrying bulk cargoes. It is not surprising because inland waterway vessels are able to transport more volume than trucks. On the other hand, trucks are more flexible than inland waterway vessels because the road infrastructure is extensively interconnected.

Currently the truck is a tremendous player in the transport sector. As shown in the figure, trucks carried huge amount of different types of cargoes. One challenge for the future would be the connection

between different modes of transportation systems to achieve the best and sustainable solution for a transport.

7.3. Typical types of cargoes in the inland waterway and inland truck way

In this chapter, there will be discuss the typical cargoes, which are transported by barge or truck. Both modes of transports are able to carry different types of cargoes. Nevertheless, the efficiency of the transport depends on the transport system.

<table>
<thead>
<tr>
<th>Cargo type</th>
<th>Inland waterway vessel type</th>
<th>Truck type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk in solid form</td>
<td>Bulker</td>
<td>Dump truck</td>
<td>Sand</td>
</tr>
<tr>
<td>Bulk in liquid form</td>
<td>Tanker</td>
<td>Tank truck</td>
<td>Petrochemicals</td>
</tr>
<tr>
<td>Project Cargo / Heavy load</td>
<td>Dry cargo inland waterway vessel</td>
<td>Heavy cargo truck</td>
<td>Gas turbine</td>
</tr>
<tr>
<td>Containerized cargo / Reefer</td>
<td>Dry cargo inland waterway vessel</td>
<td>Standard truck</td>
<td>40/20 Container</td>
</tr>
<tr>
<td>Automotives</td>
<td>Ro-Ro inland waterway vessel</td>
<td>Car transporter</td>
<td>Cars</td>
</tr>
</tbody>
</table>

Table 2: Own illustration of cargo and transportation mode

7.3.1. Bulk in solid form

First, there is the bulk sector. As shown in the table, bulks can be differentiated in bulk in solid form and bulk in liquid form. “The Kansas State Bulk Solids Innovation Center” describes this as substances in loose and dry conditions such as sugar, starch, minerals, chemicals, pigments, fillers, plastic resin and recycled plastics. The transportation of solid in bulk form can interpreted as an easy handling because it is just one cargo in one storage. Nowadays, there are machines, which are able to handle those cargoes efficiently. Nevertheless, the shipment of bulks in solid form can cause structural damage on modes of transport due to unsuitable cargo handling.

7.3.2. Bulk in liquid form

Bulks in liquid form are not in a stable manner. Those cargoes should always be transported in tanks or pipelines. Many liquefied cargoes are dangerous goods. That means, those cargoes are harmful for the environment and human beings. On the other hand, bulks in liquid form can be also food in liquid form, for instance, juices or water.

7.3.3. Project cargo and Heavy Lift items

Those cargoes are usually of tremendous value and heavy weight. The dimensions of those cargoes are not standardised and the loading and unloading process often needs a lot of planning. The planning is one of the most crucial points in the heavy lift sector. There are lots of different information to take into account. For instance, the Centre of gravity should always be known to make sure how to lift the item. Furthermore, those cargoes need a lot of hold capacity due to their enormous dimensions. There is a great amount of lashing materials in order to ensure that those specific cargoes are sufficiently secured during the transportation process.

69 Cf. Kansas State University (Bulk Solids Innovation Center), https://bulk-solids.k-state.edu/bulk_solids.html
There are several aspects, which make the carriage of heavy lift items to a difficult process. The transportation of heavy lift items needs a well-developed infrastructure. Furthermore, the approval times of heavy lift transportation on roads are not practicable for the shippers.\textsuperscript{72}

7.3.4. Containerized cargo

The epoch of the container turned the transportation of cargoes into a highly efficient business. Most cargoes shipped around the world can be transported in a container. In a nutshell, a container is a steel box of standardized dimensions and handling processes. Those steel boxes make the transport of various articles much easier and cheaper because the loading and unloading process is always the same. So, there is no need for extra planning or calculation to pick up the steel boxes.

<table>
<thead>
<tr>
<th>Container title</th>
<th>Dimensions [m]</th>
<th>Type</th>
<th>Max. gross weight [kg]</th>
<th>room volume [m(^3)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>20' Shipping Container</td>
<td>6.09x2.59x2.44</td>
<td>Dry, Reefer, Tanker, Flat Rag</td>
<td>30.48</td>
<td>33.20</td>
</tr>
<tr>
<td>40' Shipping Container</td>
<td>12.18x2.59x2.44</td>
<td>Dry, Reefer, Tanker, Flat Rag</td>
<td>30.40</td>
<td>67.59</td>
</tr>
<tr>
<td>20' High Cube Shipping Container</td>
<td>6.09x2.90x2.44</td>
<td>Dry</td>
<td>30.48</td>
<td>33.20</td>
</tr>
<tr>
<td>40' High Cube Shipping Container</td>
<td>12.18x2.90x2.44</td>
<td>Dry</td>
<td>30.40</td>
<td>67.59</td>
</tr>
</tbody>
</table>

Table 3: Own representation of common types of containers\textsuperscript{73}

7.3.5. Container comparison between a 44 tons truck and an “Europaschiff”

The comparison affects one truck of 44 tons load capacity and an “Europaschiff” with a load capacity of 1,400 tons. The pictures illustrate an example, how many 20’ Containers can be transport on one 44 tons truck and one “Europaschiff”. The cargo area dimensions of the “Europaschiff” is 60m x 7.50m.\textsuperscript{74} The total dimension of a standard 20’ Container are given in the figure. This calculation is purely theoretical and should give an idea of the load capacity of an “Europaschiff”.

![Figure 14: Own illustration of ship and truck dimensions](image)

7.3.6. Import container handling

The illustration below shows a typical process of import container handling at a container terminal. Sea ships will be unloaded by one or several gantry cranes. The number of gantry cranes depends on the ship dimensions. Afterwards, containers will go to a container storage. Furthermore, containers will be transported out of the container storage to a Rubber tyred gantry crane, which will load containers to a train or a truck. Finally, containers will be carried to the hinterland by train or truck.

\textsuperscript{72} Cf. DVZ Online (Bundeskabinett beschließt neue Gebührensätze für LKW Maut), https://www.dvz.de/rubriken/logistik/schwergut/detail/news/schwergut-lage-stabil-probleme-bleiben.html

\textsuperscript{73} ContainerContainer (Shipping Container Dimensions), https://www.containercontainer.com/shipping-container-dimensions

\textsuperscript{74} Cf. FH Osnabrück (Binnenschiffahrt auf dem Dortmund-Ems-Kanal), http://www.wsa-mappen.de/amtебereich/dek/images/Birsch-DEK.PDF
Automotives

“Ro-ro cargo items include all the various types of commercial vehicles for road transport, roll trailers and other pieces that are driven aboard the ship”.

Automotives or also known as vehicles/Ro-ro cargoes are special cargoes, which need a special mode of transportation system. Moreover, those cargoes need a different load securing than other kind of cargoes due to the fact that vehicles have tires. That is to say, those cargoes are able to roll away during the transportation process.

It is crucial that all Ro-ro cargoes have to be checked before they will be dispatched. Those cargoes are already sold and ready to use. Following requirements for the transportation of automotives should be taken into account:

- Cargoes have to be safely stowed and secured.
- Lashings have to be attached at proper locations.
- Cargoes should always be under surveillance to avoid theft.

8. Costs

8.1. Infrastructural costs for inland waterway transportation

In November 2018 the German government decided to eliminate the fees for the German inland waterway system. This action is supposed to strengthen the inland waterway transport. Due to the cancellation of the fee inland waterway transportation providers and their clients will save about
45.000.000 € per year. Only the river Mosel and the Kiel-Canal are not included. The fee for traveling on the river Mosel between Koblenz and Thionville depends on the cargo carried. The terms of payment are split into different cargo categories. The charge applies per tons of cargo per kilometre or per container. The prices vary between 0.27 €-cent per tkm and 0.644 €-cent per tkm. For a container up to 20’ a fee of 0.25 € and for a container with a length of more than 20’ a fee of 0.05 € are charged per kilometre. Furthermore, a fee for passing the locks is applicable. An inland waterway vessel with more than 600 m³ will be charged with 6.00 € per lock. The calculation for costs applicable when passing the Kiel-Canal is based on inland waterway vessel’s load capacity. The cost level is rated on half the inland waterway vessel’s gross tonnage, e.g. an inland waterway vessel with a load capacity of 2,100 tons a navigation tax 349 € will be charged as well as 783 € for canal taxes.

8.2. Infrastructural costs for truck transportation

When using German motorways and highways for the transportation of goods with a vehicle with a weight of more than 7.5 tons tolls must be paid. The exception is the A6 between the German-French borderer and Saarbrücken-Fechingen, as well as the A5 between the German-Swiss borderer and the German-French borderer. That means that for almost the entire road network of about 51,000 km is subject to toll fees. The toll includes costs for the infrastructure, that means for the actual use of the highway or motorway, as well as costs for air and noise pollution. The exact amount of applicable toll fees depends on the number of axles, the weight of the vehicle, the emission class and a blanket amount for noise pollution. For transporting a container via German highways and motorways using a HGV with the emission class Euro 6 a toll fee of 18.7 €-cent per km incurs. This includes an amount of 1.1 €-cent for the external costs of air pollution, 0.2 €-cent per km for the external costs of noise pollution. The main share of the toll fee are the costs for infrastructure with 17.4 €-cent per km.

8.3. Terminal Fees

There is a difference in fees when a container is delivered or picked up by an inland waterway vessel or an HGV. If a container is delivered or picked up by truck only a handling fee is charged, but if a container is delivered by an inland waterway vessel it must be considered, that tonnage dues and quay dues will be charged. Delivering a container at the “NTB Terminal” in Bremerhaven by inland waterway vessel means fees of 279 € in addition to tonnage dues of 0.50 € per gross tonnage of the inland waterway vessel for the first 24 hours, after that a higher amount of tonnage dues will be charged for each 12 hours and quay dues of 4.75€ per 1.000 kg of discharged or loaded cargo. In comparison, delivering a container by truck is only 119 €.
8.4. Costs to operate a vehicle

8.4.1. Transport by truck

There are various kinds of trucks and trailers, so the costs vary a lot. It is not possible to calculate one amount that is applicable for any kind of truck. Of course, there are higher expenses for a refrigerated trailer, due to higher purchase costs, higher fees for insurance and diesel consumption. In this case costs for a tractor semitrailer with chassis for container transport is used as the basis of calculation. It is assumed, that it is about 100,000 € to buy a tractor semitrailer and about 20,000 € to buy a chassis. For different kinds of insurance like carrier’s liability, liability and hull insurances for tractor semitrailer and chassis costs of about 4,200 € per year incur.\(^91\) Another important factor for the running costs of a truck is its drivers salary. In Germany a driver earns about 2,400 €\(^92\) plus further expenses of 28 € per day\(^93\). This leads to costs of about 3,600 € for personnel because the employer must pay for social insurances for each employee in relation to their salary. In 2018 the average costs for Diesel were 1.289 € per litre\(^94\), that leads to a fuel consumption price of about 0,425 € per kilometre, assuming a truck needs 33 litre per 100 km.\(^95\) One of the highest consumable parts of a tractor or unit and a trailer are their tyres. Running performance vary a lot, depending on drivers driving behaviour and position of the tyre on HGVs or chassis, e. g. a tyre on a drive shaft will not last as long as tyres on other axles. So, the running performance might be between 80,000 and 350,000 km, so an average value of 200,000 km is based. Furthermore, an average price of 425 € per tyre is assumed.\(^96\)

Assuming an HGV runs about 560 km a day, due to drivers working days of 20 days a month, an average speed of 70 km/h, a lifetime of 1.000,000 km for the semitrailer tractor and 8 years for the trailer,\(^97\) going by HGV means costs of about 0.80 € per kilometre. Due to lack of reliable figures for maintenance, repair and other unforeseeable costs estimated 10 % are added on top, so final costs for one kilometre by HGV are 0.88 € but keeping in mind that further costs depending on the route like toll fees must be added.

8.4.2. Transport by inland waterway vessel

When calculating costs for a transport by inland waterway vessel usually a daily rate is based for the calculation. This rate includes the purchase value, depreciation and amortisation, staff, interest, insurances, maintenance and repair and administration costs. For an inland waterway vessel of the size of a Europaschiff with a gross tonnage of 1.665 tons a common daily rate is about 1,400 €. The main components of the daily rate are the costs for personnel of 38 % and depreciation of 32 %. It depends on the routing how much cargo can be loaded. If a draught of 2.50 m is possible 1.269 tons can be loaded, whereas a draught of 2.80 m leads to a payload of 1.500 tons. The more cargo loaded the more time is needed for loading and discharge, what affects the travel time for this journey. Consumption per hour is about 80 litres, a fuel price of 0.55 € is based. About 10 % of the costs for fuel

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91 Cf. Interview Schlosser.
must be added as costs for lubricants. When calculating the costs for a certain voyage the operating type must be concerned. In inland waterway transport it is possible to operate a vessel either 14 hours in 24 hours, this is called operating form A1, or 18 hours in 24 hours, this is form A2, or form B which means an operation of 24 hours. It depends on the operating form how much travel time is needed from the place of loading to the place of discharge.

8.5. External costs caused by different modes of transport

External costs are costs incurring by someone’s activities but affecting someone else and are not covered by the producer. As an example, in the transport sector there is a car, which exhausts fumes, that not the driver but someone else inhales and affects his health, what leads to medical costs. These are external costs of driving a car.

“The Handbook on the external costs of transport” published by the European Commission takes into account costs for accidents, air pollution, climate change, noise, congestion, costs of well-to-tank emissions, of habitat damage and other external costs like soil and water pollution, up- and downstream emissions of vehicles and infrastructure as well as external costs in sensitive areas. The handbook shows figures as total costs in the European Union in 2016 per mode of transport, but also splits these costs in tonne-kilometre (tkm) as well as vehicle-kilometre (vkm). It should be considered that one mode of transport might produce a much higher amount of costs per vehicle-kilometre than other modes of transport but due to high differences in capacity the high amount of costs per vehicle-kilometre might end up in low costs per tonne-kilometre. Therefore, only costs per ton-kilometre will be focussed on in the following, what makes it more comparable.

8.5.1. The external costs of HGV and Inland Waterway vessel in comparison

![Overview of external costs of HGV and Inland waterway vessel](image)

Figure 16: Overview of external costs of HGV and Inland waterway vessel

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99 Cf. RheinSchPersV §3.10 1.
101 Cf. ibid, pp. 5-6.
102 Own presentation based on European Commission, (External costs, 2019).
The chart gives an overview of the total amount of external costs of HGV and Inland waterway vessel. It illustrates the different components of the external costs per mode of transport.

8.5.1.1. External costs of accidents

The external costs for accidents include different components like human costs, these are costs for pain and suffering as a result of an accident, medical costs, which are the costs of the medical treatment, administrative costs, like costs for the police, production losses, because people involved in an accident often cannot return to work immediately, and material damage.103 Heavy Goods Vehicles (HGV) cause 1.3 €-cent per tkm. In comparison, inland waterway vessels cause only 0.1 €-cent per tkm.104

8.5.1.2. External costs of climate change

Some Emissions like N₂O and CH₄ but especially CO₂ lead to global warming and climate change. When calculating the external costs for climate change, these are the emissions focussed on. An HGV causes costs of 0.53 €-cent per tkm and inland waterway vessel results in 0.27 €-cent per tkm.105 Regarding external costs for climate change the inland water vessel performs economically friendlier than the HGV.

“The Central Commission for the Navigation of the Rhine” published figures for the emission of CO₂, particulate matters and NOx in their annual report 2017. A Well-to-Wheel base was chosen, that means all generated pollutants from the fuel extraction, fuel production up to emissions caused by combustion are considered.106 Emission between HGV and inland waterway vessels are compared. For road transportation an HGV loaded with 7.5 tons and an HGV with articulated lorry loaded with 29.9 tons were chosen. Five different inland waterway vessels are presented, a „Kempenaar” loaded with 616 tons, a Rhein-Herne-Kanal-Schiff with a capacity of 1.537 tons, a großes Rheinschiff with 3.031 tons, a gekoppelter Schubverband with 5.046 tons and a 4-Leichter-Schubverband with 11.181 tons107

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104 Cf. Ibit., p. 38.
105 Cf. Ibit., p. 66.
106 Cf. Sekretariat der Zentralkommission für die Rheinschifffahrt (EUROPÄISCHE BINNEN SCHIFFFAHRT MARKTBEOBACHTUNG 2017) p.126.
107 Cf. ibid., pp. 128-129.
The chart illustrates the emission of CO₂ in g per tkm. It is clearly to see, that an HGV loaded with 7.5 tons of bulk cargo is producing a very high amount of CO₂ per tkm. An HGV with an articulated lorry transporting a high amount of cargo is emitting only a third of CO₂, what is about 82 g per tkm. Different sizes of inland waterway vessels are shown in the chart. All of them are emitting much less CO₂ than an HGV with articulated lorry. A Kempenaar and a Rhein-Herne-Kanal-Schiff produce about half the amount of CO₂ a heavy HGV does per tkm and a großes Rheinschiff, a Koppelverband and a 4-er Schubverband emit the most moderate amount with only 20-22 g per tkm.

Comparing these figures with the external costs for climate change published by the European Commission in the Handbook on the external costs of transport of an HGV and an Inland Waterway vessel a similarity is recognizable. There are about 0.53 €-cent per tkm for an HGV and 0.27 €-cent per tkm for an Inland Waterway vessel, so about 50 % less costs. Comparing the emitted amount of CO₂ per Inland waterway vessel it is also 50 % or even less. The external costs are not only calculated on CO₂ but also on other greenhouse gases and specific factors what might be the reason for not being totally concurrent.

8.5.1.3. External costs of air pollution

There are other emissions, which are not connected to climate change but do affect the air quality. When running an engine different kinds of air pollutants like nitrogen oxides (NOₓ), Sulphur dioxides (SO₂) and particulate matters are produced, what leads to different impacts on the human health, crops, to damage on buildings and other problems of the ecosystem like the loss of biodiversity. These aspects are considered when calculating the external costs of air pollution caused by traffic. An HGV produces costs of about 0.76 €-cent per tkm. Whereas inland waterway vessels cause external costs for air pollution of 1.29 €-cent per tkm. So obviously inland water vessels do produce quite a high amount of air pollutants in comparison to HGV.

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108 Cf. Sekretariat der Zentralkommission für die Rheinschifffahrt (EUROPÄISCHE BINNENSCHIFFFAHRT MARKTBEOBACHTUNG 2017), p.130.
109 Cf. European Commission, (External costs, 2019), p. 64
110 Cf. ibid., p. 44.
The Central Commission for the Navigation of the Rhine published figures for the emission NO\textsubscript{x} in their annual report 2017.

The chart illustrates the emission of NO\textsubscript{x} of different kind of vehicles. A light HGV causes about 1.8 g per tkm whereas an HGV with a higher amount of cargo loaded only emits 0.3 g per tkm. The different kinds of inland waterway vessels produce between 0.17 g per tkm and 0.52 g per tkm. A Kempenaar and a Rhein-Herne-Kanal Schiff are producing more NO\textsubscript{x} than an HGV but larger inland water vessels are emitting up to 50 \% less than an HGV. Obviously, the amount of NO\textsubscript{x} per tkm depends a lot on the inland waterway vessels’ size and carried amount of cargo. These figures show that the generated amount of NO\textsubscript{x} of inland waterway vessels are relatively high and must be worked on. There are different measures which can be taken to reduce the emission of NO\textsubscript{x}. These measures are mainly quite expensive and difficult to implement in the business. Probably the most effective and reasonable measures are the reduction of speed, on-board information systems and better voyage planning.

8.5.1.4. External costs of noise

Due to urbanisation and increasing traffic volumes external costs of noise are getting more and more significant. The number of people living in cities is growing continuously. These people are the ones who suffer the most from the noise caused by traffic. Noise are all different kinds of sounds that are not wanted and cause health problems. “The Handbook on external costs of transport” is only focussing on the costs for noise made by road, rail and aviation. Inland waterway vessels are very silent in comparison to the other modes of transport and inland waterway transportation is mainly taking place in sparsely populated areas, which makes the external costs negligible. The external costs of noises for HGV are depending on its weight. A lighter HGV with up to 7.5 tons causes 1.2 €-cent

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111 Cf. Sekretariat der Zentralkommission für die Rheinschifffahrt (EUROPÄISCHE BINNENSCHIFFFAHRT MARKTBEOBACHTUNG 2017), p. 131.
112 Cf. Ibid., p. 132.
113 Cf. Ibid., p. 135.
114 Cf. Ibid., p. 76.
115 Cf. Ibid., p. 76.
per tkm, whereas a heavy HGV with more than 32 tons only causes 0.4 €-cent per tkm.\textsuperscript{116} For the graph an average value of 0.5 €-cent is taken as basis.

\subsection*{8.5.1.5. External costs of congestion}

The expression congestion must be defined in different ways to make it suitable for different kinds of transports. In road transportation congestion means that a vehicle slows down what leads to a delay of following vehicles.\textsuperscript{117} For other modes of transport, it must be concerned, that schedules are actually preventing them from congestion, but it might happen, that problems with one service might cause a delay of other services, so that congestion costs incur. Congestions costs are the costs for the delay and deadweight loss.\textsuperscript{118} HGVs generate delay costs of 0.25 €-cent in urban traffic and 3 €-cent in inter-urban traffic. Deadweight loss costs are so low in inter-urban traffic, that it is only possible to state the number for vkm. These are 0.5 €-cent per vkm but in urban traffic there are 0.4 €-cent per tkm.\textsuperscript{119} “The Handbook on external costs for transport” quotes Christidis and Brons regarding congestion costs for inland waterway system. They say, it “can be assumed to be negligible for EU Member States”.\textsuperscript{120}

\subsection*{8.5.1.6. External costs of well-to-tank emissions}

“The Handbook on external costs of transports” does not only focus on external costs which are only related to the transport process. It also considers costs of so-called well-to-tank emissions. These are emissions, like greenhouse gases and air pollutants that are emitted during the production of energy which is needed to operate a vehicle.\textsuperscript{121} A HGV creates about 0.2 €-cent per tkm of well-to-tank costs whereas an inland water vessel only bears costs of 0.13 €-cent per tkm.\textsuperscript{122}

\subsection*{8.5.1.7. Costs of habitat damage}

Transport also effects the nature and landscape. The construction of infrastructure leads to the loss and fragmentation of habitat, the emissions emitted deteriorate the habitat.\textsuperscript{123} The calculated external costs for habitat damage are based on the network length of each mode of transport.\textsuperscript{124} The costs of 0.19 €-cent of an HGV per tkm are very similar to the costs caused by an inland vessel. These are 0.2 €-cent per tkm.\textsuperscript{125}

\subsection*{8.5.1.8. Other external costs}

“The Handbook on external costs of transport” also considers other external costs like costs of water and soil pollution\textsuperscript{126}, costs of up- and downstream emissions of vehicles for infrastructure, which are not covered under costs for well-to-tank emission costs\textsuperscript{127}, costs in sensitive areas (e.g. mountainous

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{116} Cf. Sekretariat der Zentralkommission für die Rheinschifffahrt (EUROPÄISCHE BINNENSchIFFFAHRT MARKTBEOBACHTUNG 2017), p. 81.
\item \textsuperscript{117} Cf. European Commission, (External costs, 2019), p. 87.
\item \textsuperscript{118} Cf. ibid., p. 88.
\item \textsuperscript{119} Cf. ibid., p. 96.
\item \textsuperscript{120} Cf. ibid., p. 104.
\item \textsuperscript{121} Cf. ibid., p. 105.
\item \textsuperscript{122} Cf. ibid., p. 108.
\item \textsuperscript{123} Cf. ibid., p. 117.
\item \textsuperscript{124} Cf. ibid., p. 118.
\item \textsuperscript{125} Cf. ibid., p. 121.
\item \textsuperscript{126} Cf. ibid., p. 122.
\item \textsuperscript{127} Cf. European Commission (External costs), p. 123.
\end{itemize}
\end{footnotesize}
regions)\textsuperscript{128} and further externalities of transport. For all these aspects no concrete numbers for external costs are given.

### 8.6. Comparison of costs for different relations

In these examples the transport costs of a 20’ container (TEU) by HGV and inland waterway vessel will be compared. Since the costs of an inland waterway vessel of class “Europaschiff” are available, these costs are taken as basis. A “Europaschiff” can carry about 87 TEU but due to the height of bridges only two layers of containers can be carried which leads to a carrying capacity of 56 TEU.\textsuperscript{129} However, it can be assumed, that in areas where an inland waterway vessel can carry 3 layers of containers or a larger inland waterway vessel can be used, costs per TEU would be even lower due to economies of scale.

In the following, four different relations are presented, where it is common practice to transport containers by inland waterway vessel due to appropriate shippers and infrastructural conditions.

For the calculation it is assumed that 20’containers with a weight of 12.5 tons are carried. Distances, travelling times as well as times for loading and discharging are provided by inland waterway skipper Arne Harms.

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\textsuperscript{128} Cf. European Commission (External costs), p. 123.

\textsuperscript{129} Cf. Gesamtverband der Deutschen Versicherungswirtschaft e.V. (GDV) (Perspektiven des Containertransports per Binnenschiff im Seehafenhinterlandverkehr) http://www.tis-gdv.de/tis/tagungen/workshop/cs/kohlmann/kohlmann.htm
8.6.1. Fallersleben - Hamburg

<table>
<thead>
<tr>
<th>HGV:</th>
<th>Europaschiff:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distance</strong> km</td>
<td><strong>Distance</strong> km</td>
</tr>
<tr>
<td>170</td>
<td>160</td>
</tr>
<tr>
<td><strong>Costs per km €</strong></td>
<td><strong>Travel time net h</strong></td>
</tr>
<tr>
<td>0.88</td>
<td>16</td>
</tr>
<tr>
<td><strong>Distance liable to pay toll km</strong></td>
<td><strong>Consumption + lubricants (80l x 16h x 0.55€ + 10%) €</strong></td>
</tr>
<tr>
<td>153</td>
<td>775</td>
</tr>
<tr>
<td><strong>Toll fee per km €</strong></td>
<td><strong>Travel time (A1), incl. time for locks and tide h</strong></td>
</tr>
<tr>
<td>0.187</td>
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<tr>
<td><strong>Costs per HGV €</strong></td>
<td><strong>time for loading, discharging, waiting (approx.) h</strong></td>
</tr>
<tr>
<td>178</td>
<td>1</td>
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<td><strong>Transport costs per TEU €</strong></td>
<td><strong>Daily rate €</strong></td>
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<td>89</td>
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<tr>
<td><strong>External costs (4.2 €-cent/km) €</strong></td>
<td><strong>Total transport costs €</strong></td>
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<td><strong>Total costs €</strong></td>
<td><strong>Transport costs per TEU €</strong></td>
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<td>179</td>
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<td><strong>Total costs €</strong></td>
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Table 4: Comparison of costs for relations Fallersleben - Hamburg

8.6.2. Braunschweig- Hamburg

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<tr>
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<td><strong>Costs per km €</strong></td>
<td><strong>Travel time net h</strong></td>
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<tr>
<td>0.88</td>
<td>16</td>
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<tr>
<td><strong>Distance liable to pay toll km</strong></td>
<td><strong>Consumption + lubricants (80l x 16h x 0.55€ + 10%) €</strong></td>
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<tr>
<td>168</td>
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<td><strong>time for loading, discharging, waiting (approx.) h</strong></td>
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<tr>
<td>181</td>
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<td>1,411</td>
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<td><strong>Total transport costs €</strong></td>
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<td><strong>Transport costs per TEU €</strong></td>
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Table 5: Comparison of costs for relations Braunschweig - Hamburg

8.6.3. Minden - Bremerhaven

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Table 6: Comparison of costs for relations Minden - Bremerhaven

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131 Cf. ibid.
132 Cf. ibid.
8.6.4. Hannover - Bremerhaven

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<td>Consumption + lubricants (800 € x 24h x 0.55€ + 10%)</td>
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9. SWOT Analysis

9.1. Truck traffic

The modal split in Germany describes the allocation of the volume of transported goods on the different modes of transportation. When looking at the numbers, the truck plays a major role in the modal split. In 2018 around 3.200 million tons of goods were transported and with a transport service of 300 bn tkm the truck implies a share of 74.2 % in the modal split. This part of the paper will try to bring light to the strengths and weaknesses of trucks whilst measuring the mentioned points on possibly being valuable opportunities and threats to the market of the trucking business. The first step is going to focus on the trends, branches, clients and competitors in the transport market. Secondly, this part of the paper is going to highlight the strengths and weaknesses of the truck and is thirdly going to derive opportunities and threats for this mode of transport. The last step of the SWOT-Analysis is going to design actions, which need to be taken in order to avoid dangerous risks or to discern opportunities.

Nowadays the main trend in the transport branch is called sustainability, which is quite versatile, as it regards various aspects from ecological and economical as well as social standpoints. Especially the topics environment and CO2 emissions are important aspects, if the trend sustainability is faced. The government forces different parties to handle their businesses “greener”, more environmentally friendly, more sustainable. In particular organisations in the trucking business are a huge target, because of the great share of truck transport in the modal split. Therefore, many organisations are studying for opportunities to organise better and more green transports, which are more environmentally friendly through for example different kinds of power systems like electric power or LNG.

The transportation branch in Germany is facing various challenges already and also in the next years. Currently, the shortage of skilled employees is quite a problem, which is going to become even worse, if nothing is changing. In particular, the lack of truck drivers is nowadays a challenge, because the number of procreations is distressing low. But also price suppression on the market misgives the transport businesses for the following years in order to keep up with the competition.

Every business needs to make a profit and therefore it needs clients, which use the products or services. In the trucking business, enough clients are active on the market, because without transport no progress in the economy would happen. But the problem is, that the competition is quite strong and tight, so the organisation needs to specialise itself. Clients, which prefer the truck as a transportation mode, have often small amounts of goods and/or price/time-sensitive cargo. Often the clients prefer no storage strategies and therefore they choose fast and flexible transport opportunities like trucking.

When looking at the competitors, it is obvious, that different modes of transportation like train, inland waterway vessel or the plain could be competitors. But with the modal split in mind, none of them is a serious competitor for trucking.

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135 Cf. ibid., p. 13.
136 Cf. Gabler Wirtschaftslexikon (Nachhaltigkeit), https://wirtschaftslexikon.gabler.de/definition/nachhaltigkeit-41203
9.1.1. Strengths

In Germany, the street network consists of ca. 650,000 kilometres\textsuperscript{137} on about 357,376 square kilometres.\textsuperscript{138} Compared to industrial strong countries like USA (0.67 km/km\textsuperscript{2}), China (0.43 km/km\textsuperscript{2}) and France (1.6 km/km\textsuperscript{2}) Germany has one of the best road system concentrations in the world with a comparative value of 1.82 km/km\textsuperscript{2}. Just a country like Japan with a value of 3.23 km/km\textsuperscript{2} possesses a better street system. Therefore, the transportation on the street with a truck has no route restrictions and is free to drive every possible route to reach the appropriate destination. Different transport modes in the inland like train or inland waterway vessels are completely restricted to their possible routes.

Furthermore, the intense street system concentration in Germany enables favoured "door-to-door transports" for the forwarder. It is possible to reach almost every client with the truck because mostly every client has access to the public street network. Also, the truck has nearly no street restrictions so that he can access or reach every client. For the forwarder the "door-to-door transport" is easy and it includes less planning and effort in total than transports with a change of mode or extra handleings like train or inland waterway vessel. Another point is also, that the "door-to-door transport" has a minor risk of problems or accidents because the carried good doesn't need to be handled an additional time. The good just needs to be loaded and discharged once during the transport.

In addition, if the forwarder chooses the transportation mode "train" or "inland waterway vessel", the truck is almost every time included in the transport chain of goods. The reason for it is the characteristic of the train and inland waterway vessel. In Germany, it is quite infrequent, that the shipper or the consignee has access to the rail or inland waterway system. Therefore, it is not possible to provide “door-to-door transports” and it is necessary to take the truck into account for the pre-carriage and on-carriage (subdivided transport or combined traffic). Therefore, the truck is indispensable for almost every transport.

Another strength of transportation with a truck is the ability to react fast. In Germany and around Germany is a big variety of trucking companies, which can transport goods in a short advance. Often the companies are able to react fast and provide transport opportunities within a couple of days if they have spare capacity. Also, it is possible to carry the goods with a truck to every destination in Germany within one, a maximum of two, days. Moreover, the biggest advantage over the train is, that the truck doesn't have a time schedule, in which it operates like the train. Therefore, the truck is highly flexible and fast, which makes sure that forwarder and direct clients favour the transportation mode "truck".

The next point is the permanent demand for transport with trucks. In the last years, the haulage capacity of trucks recorded a steady increase up to 295.2 bn tkm in 2018.\textsuperscript{139} Since the tremendous depression in 2008, the haulage capacity never regenerated completely and it wasn't possible to reach the record value of 2008. But still in the modal split of haulage capacity the truck dominates the train (19.0 %) and the inland waterway vessel (6.8 %) with 74.2 % (2018).\textsuperscript{140} Noticeable is that only the truck increases by 1.6 %. The transportation modes train (-0.2 %) and the inland waterway vessel (-1.4 %) decreases about a specific amount of value compared to 2017. Therefore, it is expedient to

\textsuperscript{140} Cf. Ibid., p. 10.
use the truck in the transport chain because the government will always need to invest in the street network or in general in the truck transportation business.

The last important strength is the cost efficiency of truck transport. Therefore, it is important to analyse the organisation structure in Germany regarding truck businesses. In October 2015, 45,051 organisations were registered in Germany.\textsuperscript{141} That is 9.3 % less than five years ago. On the one hand, especially organisations with 2 to 3 (-20.7 %) and 4 to 5 employees (-14.3 %) have decreased remarkably. On the other hand, organisations with ten and more employees have increased heavily (+11 %). Also, the demand specifically the haulage capacity is growing steadily in the next years. For that reason, the market becomes highly competitive. Especially man-sized organisations can generate lower transport prices than smaller organisations with 1 to 5 employees. And also, the immigration of truck drivers from East Europe minimize the price dramatically.\textsuperscript{142} Therefore is the market quite interesting for customers, who like to transport goods at low prices.

9.1.2. Weaknesses

The first negative point and also the most serious is sustainability, in particular relating to emissions. The truck is the transport mode, who stresses most of the environment. In table 2 is it stated, that the truck is ejecting 103 g/tkm greenhouse gases per year. Compared to the train (19 g/tkm) and inland waterway vessel (32 g/tkm) the truck has an output of emissions, which is ten times as high respectively three times as high as emissions of a train or an inland waterway vessel. The reason for that is the possible loading capacity of a truck, which can not exceed about 25 tons. In comparison, an inland waterway vessel of type "Europaschiff", who can operate almost on every waterway, can load about 1.400 tons.\textsuperscript{143} Therefore it is more environmentally beneficial to use transportation modes like an inland waterway vessel since they can carry more tonnes of goods at once. Also, the external costs of every transport mode exhibit a lack of sustainability for the truck. For example, the average external costs of traffic noise for the truck amount to 0.79 €-cent/tkm, due to traffics or the circumstance, that the truck operates closer to private homes. In comparison, the emitted noise of an inland waterway vessel is so little it is neglectable for the ecaluation of external costs that is why it is calculated with 0.00 €-cent/tkm.\textsuperscript{144}

\textsuperscript{141} Cf. Bundesamt für Güterverkehr (Struktur der Unternehmen des gewerblichen Güterkraftverkehrs und des Werkverkehrs), pp.14-16.
\textsuperscript{142} Cf. GENIOS Branchen Wissen (Dumpingkonkurrenz aus Osteuropa), http://www.genios.de/branchen/dumpingkonkurrenz_aus_osteuropa/
\textsuperscript{143} Cf. Gesamtverband der Deutschen Versicherungswirtschaft (Perspektiven des Containertransports per Binnenschiff im Seehinterlandverkehr), http://www.tis-gdv.de/tis/tagungen/workshop/cs/kohlmann/kohlmann.htm
\textsuperscript{144} Cf. PLANCO Consulting GmbH (Verkehrswirtschaftlicher und ökologischer Vergleich, 2008), pp.16-18.
Table 8: Comparison of emissions of each means of Transport in the goods traffic

<table>
<thead>
<tr>
<th></th>
<th>Truck</th>
<th>Train</th>
<th>Barge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse gases</td>
<td>103 g/tkm</td>
<td>19 g/tkm</td>
<td>32 g/tkm</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>0.076 g/tkm</td>
<td>0.013 g/tkm</td>
<td>0.070 g/tkm</td>
</tr>
<tr>
<td>Volatile organic compounds</td>
<td>0.035 g/tkm</td>
<td>0.002 g/tkm</td>
<td>0.027 g/tkm</td>
</tr>
<tr>
<td>Oxides of nitrogen</td>
<td>0.217 g/tkm</td>
<td>0.037 g/tkm</td>
<td>0.413 g/tkm</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>0.003 g/tkm</td>
<td>0.001 g/tkm</td>
<td>0.010 g/tkm</td>
</tr>
</tbody>
</table>

g/tkm – gramme per tonnes kilometre

1 the values for the train in the table are data, which are based on the average electricity – mix in Germany
2 CO₂, CH₄ and N₂O denoted in CO₂ – equivalents
3 without methane
4 without impulse

The next weakness is the employment of truck drivers. Nowadays the organisations are searching for qualified employees, but on the markets at the moment are employees for the transport business rare und favored, in particular, german-speaking qualified employees. Also already working truck drivers are often from different countries like Poland or the Czech Republic and mostly they don’t speak German or English. Hence it is difficult to coordinate these people appropriate at the port or port gates. Furthermore on ports frequent problems with truck drivers occure due to misunderstandings and accidents.

Figure 20: BAB - Degree of utilization

145 Cf. DVZ (Bis zu 12000 USD Abwerbprämie für LKW-Fahrer, 2017), p. 3.
146 Vortrag Henriette Oesterwind, Terminal Management Duisports, Duisburg, 12.11.19.
Another huge weakness is the degree of capacity utilization of the street network system. The figure 21 shows exactly, that especially the autobahn is very busy around big cities like Hamburg, Munich, etc. and around crowded areas like Ruhr. Also, the organization "ADAC" published last year, that 745,000 traffics were noticed on german autobahns. This is the highest recorded number of traffics in Germany and it has quadrupled from 2011 to 2018.\(^{147}\) Therefore it is important to invest in the street network to strengthen the street capacity utilization for more reliable truck transport.

The last important point is the transport restriction for a couple of days. In Germany, trucks are not allowed to drive Sundays or on public holidays like new year eves, first and second Christmas day and so on.\(^{148}\) The reason for that is the already busy street network utilization. Especially on Sundays or public holidays, average consumers like to travel and therefore they often use their cars and the autobahn. In order to balance the utilization and avoid bigger traffics, the german government adopts this law. They made only exceptions for combined traffics (rail + truck/ship/inland waterway vessel + truck) or perishable goods. For example, inland waterway transportation has no restrictions at all regarding driving bans.\(^{149}\)

### 9.1.3. Opportunities

The market for truck transport is already quite big and variegated. But the international market and the trading connections between a major number of countries will forecast a promising increase in the transport business in the next years.\(^{150}\) The "Bundesagentur für Güterverkehr" published expected prospects for all-modal freight transports of 1.7 % (freight transport volume) and 2.5 % (transportation service) in 2020 and 2021 in Germany.\(^{151}\) Also, they anticipate, in particular for the freight transport on the street, an increase of 2.7 % of freight transport volume and 2.6 % of transportation service in the next years in Germany. These circumstances are a promising opportunity for the transport business and the appertaining involved parties. The reasons for the increase can be on the one hand the growing market of all-modal freight transports, but on the other hand also the "Just-In-Time"-concept (JIT), which becomes more and more integrated into business strategies.\(^{152}\) JIT means that organisations nowadays try to reduce the storage of goods to zero by planning the supply chain as efficient as possible. For example often in production sits parts or goods, which are needed for processes, are delivered on the day before or on the same day, when they are in demand. Therefore often the truck is a main part of the supply chain, because of its strengths. The organisations are able to use the flexibility and quickness of this transportation mode. Especially in unpredictable situations, it is very helpful to have a flexible component in the chain in order to avoid deficiencies or additional costs. Furthermore, the truck is able to perform "door-to-door-transport", which minimise the number of handlings. Every handling includes a particular risk, which needs to be estimated for a successful process. The most important risks for organisations are the possibility of damaging the goods or a significant delay. In particular, JIT-concepts need components, which are dependable and safe in order to perform at a high level. Therefore "door-to-door-transport" reduce the risks and assist with a high level performing supply chain.

147 Cf. ADAC, Staubilanze (Neue Rekordlängen), https://www.adac.de/der-adac/verein/corporate-news/staubilanze/
150 Cf. DVZ Online (Güterverkehr wächst in den Jahren 2018 bis 2020 weiter).
152 Cf. Roy, Jaques (Recent trends in logistics and the need for real-time decision tools in the trucking industry, 2001), S. 2.
The next huge opportunity for the truck transport business is the “Goods-structure-effect” (in German “Güterstruktur-Effekt”). Nowadays more and more national economies produce and consume more high-quality consumer and capital goods than bulk goods. Also, it was noticed that the average weight per transport order reduced and the demand for smaller and individualised goods increased.\(^{153}\) Which leads to the fact that especially the truck profits because of its strengths and system advantages in comparison to train and inland waterway vessel, which obtain their strengths mostly in transporting greater amounts.

9.1.4. Threats

One of the most challenging threats is the degree of capacity utilisation of the street network. Specialy because of the steady increasing haulage capacity of freight transport on the street the traffics and road utilisation are growing as well. In figure 21 it is obvious that the autobahn network in Germany are already congested and it is hard for them to keep up with the changing market. In order to balance the situation, the government already updated the road tolls since 2019 to generate more money for investments in the street network. But also for the next years, additional toll increases are imageable, which allow the freight rates for street transport to rise. That means that different transportation modes become more interesting for the customer out of financial dimensions.\(^{154}\)

The next important threat is the endangerment of the environment by trucks. In table 2 it is noticeable that the truck is not environmentally friendly compared to train and inland waterway vessel. The volume of goods, which are transported by truck every day, superimposes the volumes of train and inland waterway vessel to a large extent.\(^{155}\) Therefore it is important, especially for the government, to shift volumes of goods more to different more environmentally friendly modes of transportsations. In order to accelerate the process, the German government targets to introduce CO2-taxes. They state that parties, which produce CO2, need to pay for environmentally damage. Also, the experts estimate that the price of diesel will raise with the CO2 tax in Germany.\(^{156}\) These circumstances mean for trucking companies that the costs of transport will increase and therefore the customer also needs to pay more for their transportation of goods. Furthermore, these trends will probably bring about fundamental change, which can be very interesting for the next years.

\(^{153}\) Cf. FIS für Mobilität und Verkehr (Güterstruktur-Effekt), https://www.forschungsinformationssystem.de/servlet/is/39447/


\(^{155}\) Cf. Destatis (Beförderungsmenge und Beförderungsleistung nach Verkehrsträgern), https://www.destatis.de/DE/Themenv/Branchen-Unternehmen/Transport-Verkehr/Gueterverkehr/Tabellen/gueterbefoerderung-tr.html?processing=6a29387d40e88f2f083b6c1d1b452f18

Another relevant threat is the dangerous lack of employees or well-trained employees for the following years. Especially in table 3, it is evident that the section "65 and more" got a great increase of 7.9%. This shows that the existing drivers are quite old and that the trucking business loses a great amount in the next couple of years. In comparison, the section "18 to 24" only got 1.7%, which means that the important trainees can not compensate for the loss of drivers, which becomes unable to work due to age. Now in order to get a conceivable idea, the “Kraftfahrtbundesamtes” found out that about one million drivers are 45 and older and that about 67.000 drivers quit the employment for retirement every year. The problem is here that only 27.000 people start their employment as a truck driver, so there is a lack of 40.000 drivers every year. Also, the steady increasing haulage capacity in the following years requires a strong balanced employment situation in the transport business. If the situation does not improve in a timely manner, then a particular number of organisations need to close their businesses, because of missing trainees. Consequently, the competition gets less and the freight rates will rise due to less offer on the market.

After looking at the strengths, weaknesses, opportunities and threats of freight transportation by truck, it is now possible to carry out improvement strategies for the next years. When considering the threats it became evident that different significant factors danger the market or the business. Especially the congested degree of capacity utilisation of the street network is a grand purpose for toll raises. Also, the environmental problems regarding the truck lead to the CO2-tax und the increase of the diesel price. All these circumstances threaten the market, the organisations and the freight rates. Therefore it is relevant to consider suggestions for improvement.

In consideration of the strengths, the truck is able to use its strengths in interaction with the strengths of different transportation modes like the inland waterway vessel to minimise the significant threats. On the one hand, the truck is indispensable for almost every transport because of its flexibility and compatibility. Also, the strong networked street system with almost no restraints for trucks are significant to work with the inland waterway vessel, because the inland waterway vessel is limited to the network of river and canals. On the other hand, the inland waterway vessel can carry a greater capacity of goods at once, for example, the common inland waterway vessel "Europaschiff" can load 1.400 tons. In comparison, trucks are only allowed to have a maximum total weight of 40 tons at

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once. Furthermore, the inland waterway vessel is very reliable and accident-proof, so that the goods are not exposed to further dangers. In summary, the interaction between the truck and the inland waterway vessel would mean that it would be possible to connect flexibility and capacity at once.

Therefore the transport business needs to use more intermodal transport or combined traffic (mostly containers or semi-trailer) to make greater use of individual strengths. Especially the combined traffic profits from further advantages, because the government tries also to shift more cargo on the train or the inland waterway vessel.

Firstly every vehicle, which operates in the pre- and off carriage of combined traffic, is allowed to have a maximum total weight of 44 tons instead of 40 tons. Thus develop direct financial benefits through heavier transports. Furthermore, the vehicles for combined traffic are exempt from the transport restrictions for Sundays and public holidays unless the route of the truck from the terminal to the customer or reverse exceeds not about 150 kilometers. Another financial benefit is, that the owner of the truck does not need to pay for car tax if the truck operates in the pre- and on carriage of the combined traffic. In addition, the truck is paying fewer road tolls, because every truck kilometer not driven on the autobahn also means a reduction or avoidance of the costs of the road toll. These benefits allow the trucking company to reduce their total costs and increase their profits. At the same time, they take social and environmental responsibility through reduction of CO2-emissions, relief of the road and better work conditions for the drivers.158

In conclusion, it is to say, that the truck could minimise their risks by making more use of intermodal traffic. The interaction between truck and inland waterway vessel is quite profitable for both sides, so it would be advisable to connect them more than nowadays. Especially the environment and the daily traffic on German streets would gain strength, which could mean, that the government would reduce escalating tolls or taxes. In particular, these circumstances could help the transport business to force up and survive upcoming additional costs in the next years.

9.2. Inland waterway vessel

When looking at the numbers of the modal split in Germany, inland waterway vessels play more or less a subordinate role. 230 million tons of goods are transported, 60 billion tkm are covered annually. These numbers imply a share of 10.2 % of Germany’s modal split.159 This part of the paper will try to bring light to the strengths and weaknesses of inland waterway transportation whilst measuring the mentioned points on possibly being valuable opportunities or threats to the branch of inland waterway shipping.

The first step is going to focus on the trends, branch, clients and competitors in the transport branch. Secondly, this part of the paper is going to highlight the strengths and weaknesses of inland waterway transportation and is thirdly going to derive opportunities and threats for this mode of transport.

Sustainability is the word that can be used to describe the trend in the transport branch and it is quite versatile, as it regards various aspects from ecological, economical as well as social standpoints.160

Economies of scale is a term that often comes to mind when thinking about inland waterway transportation. Developments over the recent decades have made it possible to enlarge what is viewed as a shipload. Processes are being digitised. These processes include the planning of load distribution on the chosen mode of transport, the transmission of paperwork to the respective authority, communication with the shipping agent or even newer developments such as the announcement of arrival at locks to reduce waiting times and fuel waste. The wasting of fuel brings us to another important development in the transport sector, which is often described as green shipping. In the branch of inland waterway transportation this does not only include moving towards less, but also using engines running on alternative fuels (e.g. electricity, hydrogen, LNG) or improving the design of ships. Technological developments are bringing the topic of automation more into talk. Inland waterway transportation could be well suited as a pioneer for this, as the routing of waterways barely changes and the speed is not as big of a factor as it could be the case for other modes of transport. The existing assistance systems in inland waterway transportation already allow for a driverless transport, as long as there is no oncoming traffic.

The transport branch in Europe today is facing challenges. Cargo amounts are stagnating, players in all modes of transport are battling the problem of empty trips, a shortage of skilled labor because of the demographic change and also price suppression because of cabotage.

In order to make inland waterway shipping a profitable business, clients who need their goods transported are a necessity. These are often found near waterways, sometimes they even operate their own quays. Cargo that is well suited for barge transport includes bulk, non-perishable cargo which is not pressed for time. Inland waterways also offer great potential for the transport of project cargo.

Competitors of inland waterway transportation are the other modes of transport. These include transport by rail, truck or plane. Every mode of transport offers specific advantages as well as disadvantages, which are consulted when a client is making the decision of which one to choose.

After this look at the transport branch and inland waterway transportation in general it is now time to identify the strengths and weaknesses of inland waterway transport, before deriving opportunities and threats from them.

9.2.1. Strengths and weaknesses

Germany alone offers a network of inland waterways which amounts to 5.600 km. Almost every part of Germany can be reached by the use of rivers or canals. Inland waterway vessels are able to transport goods more efficiently than competing modes of transport. The reasoning for this is the amount of goods that can be transported by just one vehicle. One shipload can equal up to 175 railway wagons with 40 tons loaded or even 280 trucks with 25 tons loaded. Besides the meagre air pollution, inland waterway vessels produce only little noise pollution.

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161 Cf. Hafen Hamburg Marketing e.V. (Port of Hamburg Magazine 3.15), p. 38
A challenge that inland waterway vessels are barely facing is congestion. Traffic flow is almost always uninterrupted. Adding to this is the ability of inland waterway vessels to transport on Sundays and holidays. This makes transport by inland waterways reliable. Many different types of goods are well suited for inland waterway transport. Project cargo for example can be carried without a permit from an authority, as it is otherwise needed for a transport by truck.\textsuperscript{169} Inland waterway transportation is only facing very few accidents, which makes dangerous goods a perfect fit, as they can also be transported in a safe distance from the public, with almost no tremor and in large quantities.\textsuperscript{170} Furthermore, the transport costs in this branch are very low compared to other modes of transport. 1.000 tkm by inland waterway vessel cost 12.60 €, whilst the same transport by rail or truck costs more than 45 € respectively.\textsuperscript{171} Digitization has also found its way into the barge shipping sector. Ships are using software on-board to for example plan the correct distribution of cargo, soliciting cargo to avoid empty trips or to convey necessary paperwork to associated authorities.\textsuperscript{172} Already today the inland waterway vessel is a much-needed mode of transport. This is proved by the share of the hinterland transport the branch holds when looking at the modal split of two of the most important European ports: Rotterdam and Antwerp. Inland waterway vessels in Rotterdam are responsible for the transport of more than 40 % of all goods in the hinterland traffic, the barge share in Antwerp lies at 30 %. The Lower Rhine is frequented by around 200.000 inland waterway vessels every year, this implies an average traffic of 550 barges per day.\textsuperscript{173}

While inland waterway transportation does offer a number of strengths, there are also weaknesses to mention. One of these is the speed of transport. In Germany, inland waterway vessels are only allowed to travel at a maximum speed of 15 kilometres per hour.\textsuperscript{174} Container transport is often limited not by ship capacity, but by bridge heights. Many containerised transports can only be done with stacks of two high. While project cargo is very well suited for transport on inland waterways, most ports can’t offer the proper equipment needed in order to either place heavy loads on ships or lift

\begin{itemize}
  \item \textsuperscript{169} Cf. Vortrag Jan-Hendrik Donner (SPC), 11.11.2019.
  \item \textsuperscript{170} Cf. Vortrag Arne Harms, 09.10.2019.
  \item \textsuperscript{171} Cf. via donau – Österreichische Wasserstraßen-Gesellschaft mbH (Handbuch der Donauschifffahrt), p. 19.
  \item \textsuperscript{172} Cf. Interview Arne Harms, 26.11.2019.
  \item \textsuperscript{173} Cf. Bundesverband der Deutschen Binnenschifffahrt e.V. (Zahlen und Fakten), https://www.binnenschiff.de/system-wasserstrasse/wasserstrasse/
  \item \textsuperscript{174} Cf. Wasser- und Schifffahrtsamt Minden (Höchstgeschwindigkeiten des Kanal- und Wesergebiet), http://www.wsa-minden.de/schifffahrt/hochstgeschwindigkeiten/index.html
\end{itemize}
these off. Digitisation is a term that characterises the transport branch of today. The non-comprehensive network of the cellular network is making developments in the area of barge shipping difficult. Long and hot summers threaten the reliability of barge shipping as well. River drafts become too low and slow down traffic. This has become noticeable on the river Rhine, as barges were forced to carry less cargo than usual on 132 days in 2018. The upside of this condition was this causing political interest, which is something the barge shipping sector does not often get due to having a weaker lobby compared to other modes of transport. Another factor which influences barge shipping is the reliability of locks. Lock failures cause congestion and slow down traffic. Furthermore, the growing lack of skilled labor is not an unknown occurrence for the branch of barge shipping as well. Working in barge shipping often means not being able to come home for longer periods of time. This is making a proper realization of what is referred to as a “work-life-balance” difficult.

Inland waterways in Germany are separated into six main classes. The classes regulate which barges are allowed to use the respective river or canal. Many waterways are restricted due to a low draft. Others are restricted because they do not offer sufficient breadth for certain barge sizes or the bridges on the respective waterway were not built high enough for barge shipping at all sizes.

9.2.2. Opportunities and threats

The sector of inland waterway vessel shipping offers a number of opportunities of which their respective potentials are ready to be scooped out. One of the best opportunities that inland waterway vessels can offer is helping with the release of street traffic and city cores. It is established by German authorities that many roads are heavily frequented. This can be viewed in the following depiction, which has been created by the “Bundesamt für Straßenwesen” in 2010:

![Figure 22: Bundesamt für Straßenwesen, 2010](image)

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Inland waterway vessels are able to help with the release of street traffic, because one vessel is capable of transporting loads that could otherwise only be transported by as many as 280 trucks.\(^{181}\) Whilst roads are often highly frequented, inland waterways are able to offer a larger amount of free capacity.

Furthermore, inland waterway vessels can be used to develop intermodal transport. An intermodal transport takes place whenever goods are transported by more than one mode of transport in either the same loading unit or vehicle. The intermodal transport offers a variety of positive aspects. Trucks taking part in this are allowed to transport with a weight of 44 tons instead of the usually allowed 40 tons. Adding to this is the repeal of the ban on trucks on Sundays and holidays. Finally, intermodal transport also helps with the aforementioned release of street traffic, since part of the transport is taking place on either an inland waterway vessel or a railway wagon.\(^{182}\)

Today’s opportunities often lie in the digitization of processes. This is also the case for inland waterway transportation. Already today, boatmen on inland waters use software when on board. This may for example include a staff planning program or a program assisting with the correct distribution of cargo on board. Future innovations in this sector may include software helping boatmen on inland waters to become able to announce their upcoming arrival at a lock.\(^{183}\)

Project cargo is transported by inland waterway vessels, yet there is a sufficient amount of space on inland waterways for further transport of this type. Once more, inland waterway vehicles would be able to help with the release of street traffic. Adding to this is the fact that project cargo transports by truck are in need of a permit from authorities before they can be moved. The obtaining of the approval may take a large amount of time, which could be saved by shippers choosing to use inland waterway vessels for transport, as there is no permit needed for it.\(^{184}\)

The topic of automation could be a realistic, upcoming technology for inland waterway vessels. Since inland waterway vessels do not transport goods at a high speed, waterway routings barely change and there are no big waves for the vessels to deal with, this innovation fits well, especially in times in which there is a lack of skilled labour. In fact, the technology to bring automated inland waterway vessels onto the market already exists to a certain degree, as the software already today is able to safely guide the vessels through rivers and canals as long as there is no oncoming traffic.\(^{185}\) 3G network speed bandwidth is all that is technologically needed to introduce automation to the market.

In times of a rising awareness for climate change, shippers are looking further towards vehicles that emit less carbon dioxide compared to other modes of transport. Due to this, the branch of inland waterway vessels is moving more into the spotlight. This implies that especially newly generated transport needs today have a better chance to be transported by inland waterway vessels.\(^{186}\) Lastly, an important term in today’s logistics is the “just-in-time” principle. An important part of this is the reducing of storage space used in factories. Due to their high reliability and slow speeds, inland waterway vessels are suited for taking over in this sector.\(^{187}\)

\(^{182}\) Cf. Studiengesellschaft für den Kombinierten Verkehr e.V. (Was ist KV?), http://www.sgkv.de/de/der-kombinierte-verkehr/was-ist-kv
\(^{186}\) Cf. Vortrag Arne Harms, 09.10.2019.
Whilst the stated opportunities offer a chance for growth in the inland waterway vessel sector, there are also a number of threats that, if not properly scrutinised, will harm the development of the inland waterway transportation sector.

Even though inland waterway vessels are partly already innovating the way that they do business by using digitisation. The inland waterway transportation sector is still quite traditional. In order to not get left behind in progress by other modes of transport, further investments into digital developments will need to be taken.\(^{188}\)

Climate change is also a topic that threatens the progress of inland waterway transportation. In times of prolonged heat periods in the summertime, draft levels of rivers and canals are declining. The reliability of inland waterway vessels is threatened by this development. The time of transport is taking longer, because inland waterway vessels are either forced to slow down or simply can’t load as much cargo as they normally would. A good example for this is the river Rhine, as inland waterway vessels were forced to carry significantly less cargo than usual on 132 days in 2018.\(^{189}\)

The transport sector in general has grown a lot over time because of worldwide trades. An important factor needed to ensure economic growth for the branch is globalization. If, for example, politicians decide to take measures with the goal of shielding their countries from imports of foreign countries, the transport sector is going to suffer from the consequences of this decision. Inland waterway vessels excel when they are allowed to carry cargo on long distance trips, as the impact of loading and discharging costs becomes less significant this way. In order to realize more long distance transports by inland waterway vessels, many ports are tasked with developing port infrastructure as well as their superstructure, because the number of ports that are capable of handling heavy or bulky cargo, is manageable.\(^{190}\)

Whilst the inland waterway vessel is one of the least carbon dioxides emitting modes of transport at the moment, others are improving their ecological footprint. New engine technologies that use hydrogen or electricity as a power source are being developed and investments in other transport sectors are being made. If the inland waterway transportation sector is not able to keep up with the innovations, the branch may lose one of its biggest advantages.

Inland waterway vessels are primed for the transport of bulk cargo. As visible in the depiction below, 30.8 million tons of coal have been transported by inland waterway vessels in 2017. This implies a share in the total of inland waterway vessel transports in Germany of 13.8 %\(^{191}\).


\(^{189}\) Cf. Süddeutsche Zeitung (Niedrigwasser am Rhein), https://www.sueddeutsche.de/wirtschaft/niedrigwasser-am-rhein-die-pegel-fallen-wieder-1.4542529


In times of climate change, it is the growing endeavor of the public to switch the power source from traditional to more renewable raw materials. Adding to this is the fact, that coal is an unlasting material. The inland waterway transportation sector is threatened through this, since it is unknown to workers in the branch which kind of cargo might be able to fill the gap that will be left by the declining number of coal transports.

The lack of skilled labor is an increasing threat to many branches. The inland waterway transportation sector is not excluded from this as well. Boatmen on inland waterway vessels are often working for 2 or 3 weeks straight, following a prolonged break. Due to this, many people working in the inland waterway transportation sector are facing challenges when trying to find a “work-life-balance”, which makes it difficult for recruiters to find motivated and suitable trainees.

Due to the lobbies of other modes of transport being stronger than the one of the inland waterway transportation branch (in Germany), investments into this transportation sector are less extensive compared to others. This results in parts of the infrastructure becoming obsolete, which is most visible at the locks. Long and numerous downtimes are the result here, often causing congested waterways in the lock areas. Adding to this is the problem, that planned projects to renew existing infrastructure are often only progressed slowly. A further lack of investments may intensify this problem, which would threaten the otherwise high reliability of inland waterway vessels.

The inland waterway transportation sector is striving to be considered equal in the eyes of stakeholders. An often weaker lobby or a not very visible marketing of this mode of transport are reasons as to why the inland waterway transportation sector is often overlooked. As long as the equality between

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the modes of transport is not provided, inland waterway transportation will continue to be facing many of the named threats and challenges in the near future.\textsuperscript{195}

The final step of this SWOT-analysis will try to design a list of actions to be taken with the goal of strengthening the development of the inland waterway transportation sector. Useful measures may include the following:

- Increasing public awareness of the inland waterway transportation sector
- Increasing public spending to strengthen the waterways infrastructure
- Funding of intermodal transport
- Motivating ports to invest in their respective superstructure
- Increasing bridge heights and drafts
- Gathering further independent data for improved investment decisions
- Development of power sources ashore for inland waterway vessels to use
- Increased funding of innovative projects in the area of inland waterway transportation
- A stronger inland waterway transportation lobby
- Further improvement of engine technologies

\textsuperscript{195} Cf. Vortrag Arne Harms, 09.10.2019.
10. Creation of project films

The final product of our project are two videos. These videos should show the view of the barge operator as well as the view of the forwarder. For both videos, each with a length of three minutes, different actors of the branches were interviewed. On the one hand, Arne Harms, managing director of an inland navigation company, plays a central role. In his opinion, all logistics players must work together more closely. Jens Holhs, managing director of the port of Braunschweig, was also asked by us about this topic. He also believes that the inland waterway vessel will play an important role in the future logistics chain. The inland waterway vessel has a very important character compared to other modes of transport. Last but not least, a long-standing freight forwarder was also interviewed. Wolfgang Weber, founder of EKB Logistik, focused on environmental impacts.

Both videos were created with iMovie according to the customer’s specifications. iMovie is a video editing program from Apple. It is installed on all current Apple computers under Mac OS. Since 2010 there is also a simplified version available for the mobile iOS devices of the manufacturer, which will be extended more and more. The operation of the program is easy to learn even for untrained people. After a few hours the basic functions are understood and can be used. For this project we worked with iMovie 10.1.13, the latest version. The generated video material was imported with a resolution of 1080p. All in all, we had about 37 gigabytes of video material available at the beginning of the editing process. It was recorded at a resolution of 4K with the help of various mobile phone devices. Several tripods and gimbal were used to stabilize the recordings.

In order to simplify the assignment of the individual video sequences, they were sorted out in the beginning. Afterwards usable material could be imported into a new project in iMovie. The various video sequences were built one after the other using a previously created storyline. The audio con-

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196 Apple Inc. (iMovie), https://www.apple.com/de/imovie/
tent was then separated from the video sequences and adapted individually. Finally, we linked the independent parts with black transitions. Single parts of the videos were created using Powerpoint. Similar to the animated Powerpoint for the IWTS website, various elements fly into the picture at this point. For example, the topic IWTS is brought closer by speech bubbles at the beginning of the video. The ending of both short films has a similar structure. At this point, individual texts and logos are displayed. The PowerPoint file is exported as MP4 video and imported into iMovie. The following integration into the corresponding video then turns out to be simple.

We found the implementation of the English dubbing voice very time-consuming. It was recorded by students of the project. The separate voice track was then imported and placed at the right location. The possibility of cross-fading meant that the original German voice of the interviewees could be made almost silent. The English voice then functions as the main voice.

The inclusion of picture-in-picture recordings also proved to be extremely difficult. Partly it was desired to show graphics and video material and to play them while the interview is being continued. Due to the successful function of iMovie, we were also able to integrate this form of presentation.

![Figure 25: iMovie from Apple shown on an MacBookPro](https://www.apple.com/de/imovie/)

Finally, it can be said that the editing of the videos turned out to be very time-consuming. It took a lot of time to view the material and determine the individual video sequences for the final video. The subsequent editing became more fluid over the time. We attribute this to the increasing experience in dealing with the program.

197 Apple Inc. (iMovie), https://www.apple.com/de/imovie/
11. Conclusion

All in all, it can be said that inland waterway transportation can be an essential player in a sustainable transportation chain, but at the moment its underrepresented. To make a change in the allocation of the shares of the modes of transport inland waterway transportation needs to be promoted and become more competitive.

The project “Interreg North Sea Region #IWTS2.0” is an important factor to promote inland waterway transportation in the logistics sector and make supply chains more sustainable. Young logistics experts were chosen as target group for the two produced image videos because they are the decision makers of tomorrow.

The website www.project-iwts20.eu was created to give important information and facts about inland waterway transportation and shall guide members of the target group to take inland waterway transportation into account when planning transportation chains.

To be able to give the above-mentioned facts to the target group this scientific paper explains inland waterway vessels in detail. There are two different kinds of inland waterway vessels. On the one hand there are pushed barges which are not motorised and on the other hand “goods-motor-barges” which are motorised. The sizes of inland waterway vessels have increased in the last years. The actual numbers can be found in table 1. About 2.100 inland waterway vessels were registered in Germany in 2018.

Almost every kind of goods are transported by inland waterway vessels in Europe. Next to liquid- and solid bulk cargo also Ro/Ro cargo and containers are transported on waterways. But the transported volumes of the mentioned kind of cargoes have decreased during the last years due to low tides caused by extreme hot and dry summers. Furthermore, inland waterway vessels benefit from their large capacities that is why they are most beneficial when transporting large and heavy cargoes such a bulks or project cargoes. But also, for container- and Ro/Ro transportation inland waterway vessels can be profitable.

Most inland waterway vessels are registered in Western Europe due to the fact that a large and well-appointed canal- and river network is available in this region. About 30.177 km of waterways are available in Europe. In order to maintain the network, it is important to invest in the infrastructure. Especially in some parts of Germany locks and canal sections are not up to date due to increased inland waterway vessel sizes and outdated technologies. That is why the federal government has launched the “Federal Transport Infrastructure Plan 2030” which states that 6.5 billion € will be invested in the canal- and river network until 2030. The most important part of the European waterway network is the Rhine- and Danube area where most inland waterway transports take place. Especially the pre- and on-carriages from and to the seaports of Rotterdam and Antwerp ensure large portions of freight volumes.

Inland waterway transportation can also be essential in city logistics concepts. Many cities complain about too many trucks in the city centres, but most cities are also located next to a river or a canal. So inland waterway vessels can help reducing road traffic in the city centres by shifting cargoes from trucks to inland waterway vessels. Good examples for small barge city concepts are the beer boat in Utrecht and the port feeder barge in Hamburg.
In order to make information and data about inland waterway vessels comparable it needs to be compared to a second mode of transportation. Road transportation was chosen because it is a competitor for inland waterway transportation.

Trucking is the most common mode of transportation in Germany. About 3.1 million trucks were registered in Germany in 2018. A road network of approximately 230,000 km makes the truck the most flexible mean of transport because it can reach almost every destination in Germany due to the fact that almost every company and private households has a road connection.

To point out the sustainability of inland waterway vessels a sustainability study was carried out. First of all the 17 sustainability goals which were agreed by the “United Nations” were examined. The 17 goals can be separated into three main categories: Ecological, economical and social goals. Next, one goal of each main category was selected which applies for inland waterway transportation.

From the social goals the 3rd goal named “Ensure healthy lives and promote well-being for all at all ages” was chosen. Countries and companies should ensure that everyone can lead a healthy life. With regard to truck drivers, this means guaranteeing sufficient break times. This can only be achieved if sufficient infrastructure is provided with available parking spaces and sanitary facilities. The current situation on inland waterway vessels is different. On board, employees work up to 14 hours a day. Since an inland navigation skipper travels on a ship for around 180 days, the inland navigation working time regulation stipulates that an inland navigation skipper may work on the ship for 31 consecutive days. Here it is difficult to create a proper work-life-balance. For this reason, families are increasingly accompanying the skipper on the inland waterway vessels. Compared to trucks, it is positive to note that sanitary facilities, for example, are always available because they are permanently installed on the ship.

From the ecological category the 13th goal named “Take urgent action to combat climate change and its impacts” was selected. Without limiting greenhouse gas emissions, the global temperature will continue to rise. Germany is a party to the Paris Convention. The main goal is to reduce dangerous greenhouse gases by 2030. For this reason, the government wants to reduce CO2 emissions in many areas such as energy production, the industrial sector and the transport sector. Around 3.200 million tons of goods are transported annually by truck. At 103g CO2 per tkm, truck emissions are around 10 times higher than those of inland waterway vessels. The majority of inland waterway vessels are operated with an engine that is not much larger than that of a truck. The inland waterway vessel can therefore contribute to these goals. Finally, it can be said at this point that inland navigation is very traditional. The ships have an average age of over 45 years in which only a few innovations have been implemented. At this point there is a need to catch up in order to further reduce emissions.

The ninth goal "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation " of the United Nations was further investigated. This goal focuses on a resource-efficient, low-polluting and climate-friendly way of life, especially in sectors such as manufacturing, infrastructure and innovation. With regard to trucks, this sustainable way of thinking plays an important role in future innovations in the field of engine technology. Alternative engine concepts to reduce emissions are being developed and driven forward. Inland navigation faces similar challenges. Locks must be maintained, repaired and enlarged to ensure smooth operation. In addition, solutions must be found for low bridges in order to be able to offer the possibility of increased container transport by inland waterway vessels. Furthermore, a suitable infrastructure must be provided in the ports. Shore power connections for inland vessels or cranes for project cargo are scarce in many inland ports. A wide range of requirements are set out in the "Inland Navigation Master Plan". With its focus
on "infrastructure", "environmental friendliness and fleet structure", "digitisation", "strengthening the multimodal transport chain" and "more skilled workers", this should contribute to making inland navigation more sustainable and attractive. These measures will also bring the UN closer to its goal in this respect.

As a further point a SWOT analysis was carried out. For inland navigation, strengths in the area of project cargo and bulk cargoes could be identified due to their high carrying capacity. In addition, there are only a few restrictions on the transport of goods by inland waterway. Moreover, inland waterway vessels can relieve overcrowded roads by transferring flows of goods from the road to water as a mode of transport. A modern pushed barge with four push lighters, for example, can take and transport the load of around 280 trucks of 25 tons each. Although inland waterway vessels travel slower, they travel more consistently. Traffic jams, accidents or occupied railway sections regularly slow down the railways and trucks. In addition, the inland waterway vessel can be used as a so-called "floating warehouse". Opportunities thus arise for inland waterway vessels in combined transport. Transport chains can therefore be made much more eco-friendly by using inland waterway vessels in the main run. The above-mentioned goals of the United Nations can therefore be supported. One weakness of inland waterway vessels, by contrast, is that generally no door-to-door transport can be offered and they are accordingly dependent on combined transport. The lack of recruitment of new employees is a major risk for the sector.

On the contrary, the cost analysis showed that not only the transported ton of cargo per kilometre is cheaper than for a truck, but also the external costs of an inland navigation vessel are significantly lower. The total costs on an example route from Bremerhaven to Hanover for the transport of a container amount, according to own calculations, to 201 € for a truck and only 139 € for an inland waterway vessel. As part of this, external costs were also taken into account. They are costs caused but not covered by a mean of transport. For example, aspects such as the emission of pollutants, noise and accidents are considered and assessed with an equivalent value. A rate of 4.2 cents per tonne-kilometre has been calculated for a truck. Whereas the rate for inland waterway vessels is only 1.9 cents per tonne-kilometre, the rate for inland waterway vessels is only 1.9 cents per tonne-kilometre.

Finally, it can be said that inland waterway vessels offer many advantages. These advantages can only be realised without the competition of the transport carriers in order to be able to offer the most future-oriented and sustainable transport solution possible. Inland waterway transportation should be more considered by the logistics sector when planning transportation chains.
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1. Interview Heiner Schneehagen, Kraftfahrzeugsachverständiger, Battermann & Tillery GmbH, 15.10.2019:

- Leistung:
  - SZM: ca. 1.000.000 km
  - Chassis: Leasingdauer normalerweise 8 Jahre

2. Interview Arne Harms, Geschäftsführer einer Binnenschiffsreederei, 24.11.2019:

- Kosten Schiffstyp Europa
  - Zeit-/Marktwert 3.050.000 € Abschreibung 152.500 € Personal 180.000 €
    Zinsen 64.050 €
  - Versicherung 36.000 € Reparatur 20.000 € Reparaturrücklage 12.000 € Verwaltung 15.000 €
  - Summe 479.550 €
  - Einsatzstage p.a. 340 Tageskostensatz [€] 1.411 €
  - Großtonnage [t] 1.665 Ladetonnage 2,50 m [t] 1.269 Ladetonnage 2,80 m [t] 1.500
  - Verbrauch pro Stunde [l/h] 80 Preis pro Liter 0,55 €
  - Europa
  - Personal 38%
  - Zinsen 13% Abschreibung 32% Versicherung 8% Reparatur 4% Reparaturrücklage 3% Verwaltung 3%
  - Das Europaschiff war das Maß für den Bau deutscher Kanäle, heute ist es das GMS
  - Tankschiffe in der Binnenschiffahrt haben drei Unterzeichnungen:
    - Typ N
      ADN 9.3.3
    - Typ C
      ADN 9.3.2
    - Typ G
      ADN 9.3.1
  - Die Unterschiede grob: G = Gas; 3 Hüllen; Drucktanks
  - C = Chemie; Doppelhülle
  - N = abgestufter Typ C; meist durch Umbau vom Einhüller zum Doppelhüller bzw. altes Baujahr.
  - Offizielle Unterscheidung: siehe ADN 1.2.1 (Begriffsbestimmungen); „Schiffstypen“. Dort auch Zeichnungen vorhanden.

Interview 30.11.2019:

- Destinationen für den Vergleich würde ich wie folgt vorschlagen:
• Fallersleben - Hamburg
• Braunschweig - Hamburg
• Minden - Bremerhaven
• Hannover - Bremerhaven

• Die vier Relationen sind "reale" Stationen, die täglich per Europ-BiSchI bedient werden.

• Hannover: VW-Nutzfahrzeuge-Werk
Fallersleben: Container-BiSchI-Hafen von VW Wolfsburg Braunschweig: große GVZ-Station; u.a. DHL-Drehkreuz und Weitere Minden: 2 Container-Terminals (eins davon in II-2019 eröffnet)

• Fallersleben - Hamburg:
Reisezeit: 1,5 Tage (Schleusenzeiten und Tide ist bereits inklusive) Distanz: 160 km für Be- und Entladung insgesamt: 1 Tag (je 0,5 Tage)

• Braunschweig - Hamburg:
Reisezeit: 1,5 Tage inkl. Schleusen und Tide (von Fallersleben nach Hamburg muss 1 Schleuse mehr durchfahren werden. Die 10 km Mehrdistanz kompensieren die 1 Schleuse aber, dadurch bleibt die Reisezeit gleich)
Distanz: 170 km

• Be- / Entladung: 1 Tag (2x 0,5)

• Minden – Bremerhaven:
Reisezeit: 1,5 Tage
1 Tag Be- / Entladung (je 0,5)

• Hannover - Bremerhaven:
Reisezeit: 2 Tage
1 Tag Be- / Entladung (je 0,5)

3. Interview André Benditte, technischer Sachverständiger, Battermann & Tillery GmbH, 02.11.2019:
• Stückpreis Reifen ca. EUR 350 – EUR 500
• Laufleistung abhängig vom Einsatz, Fahrer und Qualität: 80.000 – 350.000
• Antriebsachsen haben einer geringere Laufleistung (Antriebskräfte beanspruchen den Reifen stärker)
• Reifen vom Chassis haben ebenfalls geringere Laufleistung (hohe Gewichte durch Ladung)
• Reifen von Fernfahrern halten länger – weniger bremsen und beschleunigen
• Reifen von Baustellenfahrzeuge und Kurzstreckenfahrzeuge (Verteilerverkehr) halten entsprechend kürzer.
• Ich denke, wenn du von einem Preis pro Reifen von rund EUR 425 ausgehst du von einer durchschnittlichen Laufleistung von 200.000 km, dann liegst du gut in der Mitte.
• Reifen sind einfach sehr anwendungsspezifisch und jeder Unternehmer wird diese auf sein Einsatzgebiet und seine Ansprüche anpassen, da Reifen keine unerhebliche Kostenstelle sind.
• Für das Erneuern von Reifen kannst du ca. EUR 50 rechnen – hängt sehr davon ab, wo und wer und zu welchen Stundensätzen. Viele Speditionen machen das auch selbst in ihren eigenen Werkstätten.

4. Interview Sina Schlosser, Speditions-Assekuranz Versicherungsmakler GmbH, 14.10.2019:

• Versicherungskosten LKW:
  • SZM: Kasko + Haftpflicht = 3.000 €/Jahr Verkehrshaftung: = 800 €/Jahr
  • Chassis: Haftpflicht: 150€/Jahr Kasko: 250€/Jahr
  • Gesamt: 4.200€/Jahr

5. Vortrag von Jan-Hendrik Donner, Projekt Manager bei ShortSeaShipping Inland Waterway Promotion Center (SPC) vom 11.11.2019:

• Schubleichter im Viererverbund entlastet die Straße um 2.000.000 PKW-Überfahrten
• Genehmigungen für Schwerlasttransporte auf der Straße dauern sehr lang
• Beim Binnenschiff keine Transportgenehmigung nötig
• 5600 km Wasserstraßen allein in Deutschland -> gutes bestehendes Netz, fast alle Teile Deutschlands können mit dem Binnenschiff erreicht werden
• Kohle läuft bald nicht mehr -> noch mehr freie Kapazitäten auf den Wasserstraßen
• Niedrigwasser zwar problematisch, hat aber Ruck in der Politik herbeigeführt
• Belastungen auf Straße + Schiene sind groß
• Problem der 3-lagigen Containertransporte durch Brückenhöhen
• SGKV: Chancen des Kombinierten Verkehrs
• Problem: Viele Häfen haben nicht das Equipment, um schwere Ladung auf Schiffen zu platzieren bzw. von ihnen zu löschen
• Reduzierung der krebsserregenden Partikel
• Kein Sonn- und Feiertagsverbot
• Binnenschiff als Lager
• Identifizierung von Rundläufen und Konsolidierung von Einzelverkehren
• Hohe Versorgungssicherheit durch ungestörten Verkehrsfluss
• Fachkräftemangel zwar bei allen Verkehrsträgern, Binnenschiff braucht aber kaum Personal (bei hoher Ladungsmenge)
• Schwache Lobby für das Binnenschiff
• Binnenschiffer einer der best bezahltesten Ausbildungsberufe Deutschlands
• Wenig Aufnahme von Daten in der Binnenschiffahrt, diese ist aber nötig um Verbesserungen herbeizuführen
• Belastung der Verkehrswege maximal in Schleusengebieten problematisch
• Schleusen -> Verstopfung, Ausfälle
• Umsetzung von Infrastrukturmaßnahmen schleppend
• Bei eingefahrenen Transporten ist es schwierig, auf das Binnenschiff umzulegen
• Neue Transportaufkommen haben größere Chancen auf das Binnenschiff umgelegt zu werden
• Digitalisierung: Nötig ist Voranmeldung bei Schleusen
• Binnenschiffe nutzen an Bord jetzt bereits: Personalprogramm, Gefahrgutprogramm
• Wenig Bereitschaft zur Weiterbildung
• Mobilfunknetz muss dringend ausgebaut werden
• 3G Netz könnte für autonomes Fahren bereits ausreichen

5. Interview Henriette Oesterwind, Terminal Management, Duisburger Hafen AG, 12.11.2019:
• LKW-Fahrer häufig osteuropäischer Nationalität und sprechen teilweise weder Deutsch noch Englisch
• Häufige Unvorsichtigkeiten bei Passieren der Gates oder beim Operieren auf dem Terminal
• Port-Gates des Öfteren beschädigt
• Stehen unter gewissem Zeitdruck