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Sustainability Challenges within the Transport of Goods
Road Freight in Focus: Contrasting Portugal and Germany

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Master in International Management

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BUSINESS
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Department of Marketing, Operations and General Management

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“Progress is impossible without change, and those who cannot change their minds cannot change anything.”

-George Bernard Shaw

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I ought first to thank the participating organizations for the willingness to share their knowledge and contribute to my study. A very special thank you goes out to my supervisor Professor Florinda Matos; for your constant support and guidance with my research process.

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Resumo

A mudança climática tem sido um assunto recorrente e muito presente em nível internacional. O ecossistema mundial é fortemente afetado pelas atividades humanas em relação à inovação industrial e também ao aumento do consumo.

O setor de transporte sozinho é responsável por cerca de 26% das emissões globais, com o transporte rodoviário e a aviação nas posições de liderança. Esta dissertação enfoca o transporte rodoviário, mais especificamente o transporte rodoviário de cargas, respondendo por aproximadamente metade das emissões relacionadas ao transporte rodoviário.

Com o objetivo de elaborar desafios comuns de sustentabilidade no setor do transporte rodoviário de mercadorias, esta dissertação centra-se em dois países, Alemanha e Portugal. Representantes de quatro transportadoras são questionados sobre suas opiniões sobre os desafios da sustentabilidade. As respostas são acompanhadas pela visão de um renomado instituto de pesquisa.

Com base na análise, esta dissertação fornece uma avaliação do progresso da empresa e da prontidão para atingir as metas do European Green Deal, na Europa. As conclusões resultantes são apresentadas com base em desafios táticos e estratégicos de complexidade diferente.

Palavras-chave: Transporte, Frete Rodoviário, Transporte de Mercadorias, Mudanças Climáticas, Redução de CO_2, Desenvolvimento Sustentável.

Abstract

Climate change has been an occurring and very present subject on an international level. The world's ecosystem is heavily affected through human activities in relation to industrial innovation as well as rising consumption.

The transport sector alone is responsible for about 26% of global emissions with road transport and aviation in the leading positions. This dissertation sets focus on road transportation, more specifically road freight, making up for approximately half of the emissions related to road transportation.

In order to elaborate on common sustainability challenges within the sector of road freight, this dissertation focuses on two countries, Germany and Portugal. Representatives of four road transportation companies are questioned on their opinions concerning sustainability challenges. The answers are accompanied by the view of a renowned research institute.

Based on the analysis, this dissertation provides an assessment of the company's progress and readiness to achieve the European Green Deal targets. The resulting findings are presented based on tactical and strategic challenges of different complexity.

Key Words: Transportation, Road Freight, Transport of Goods, Climate Change, CO_2 reduction, Sustainable Development.

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List of Abbreviations

CO_2	Carbon Dioxide
GHG	Greenhouse Gas
IEA	International Energy Agency
LCV	Light Commercial Vehicle
MFT	Medium Freight Truck
HFT	Heavy Freight Truck
ICT	Information and Communications Technology
3D	Three Dimensional
ERS	Electric Road System
EGD	European Green Deal
UK	United Kingdom
LS	Luís Simões
PD	Paulo Duarte Transportes
ToF	Trans-o-flex
BLG	BLG Logistics
CO_2e	Carbon Dioxide Equivalent
SQAS	Safety and Quality Assessment for Sustainability

CHAPTER 1 – INTRODUCTION

1.1 Research Rationale

Humanities industrial innovation and rising level of consumption have a strong impact on the ecosystem of this planet. The road transport sector in the European Union is responsible for a share of about 72% of the emission generation. Although the use of passenger cars has a significant contribution, road freight is responsible for the majority of the sectors carbon footprint. The reliance of fossil fuels as energy source is the driver for that. The European Green Deal is an international target for the reduction of emissions. The sector of mobility has to reduce its emissions 90% by 2050. Among others, automation, electrification and information and communications technology are thought to contribute towards the decarbonization of the sector.

Since the growth of the road transport sector has been forecasted, their commitment towards the set target is essential. Technological research and development, tools and regulations will help with the progress.

With a focus on environmental sustainability, the rationale of this dissertation is to explore which strategies the road transport sector put in place to minimize their carbon footprint. The author puts focus on elaborating the connected challenges, differences and similarities that Germany and Portugal exhibit in their operations.

1.2 Research Aim & Objectives

This dissertation aims to investigate the possible sustainability challenges and barriers of the road transport industry. Present and future changes and developments in the industry will be considered when it comes to the adaptation in operations.

To fulfill the research aim, research questions and objectives have been formulated to guide the research process.

RQ_1: Do Portugal and Germany have differences/similarities in their sustainability behavior and progress?

RQ_2: What are key challenges when it comes to sustainability in road freight transport?

RQ_3: How can the sustainability performance in the road freight sector contribute to meet the targets set in the European Green Deal?

The research objectives have been set as follows:

- Critical review of the literature in the fields of road freight related with sustainability, namely environmental sustainability.
- Critical review of the German and Portuguese truck freight companies and their relationships and responsibility towards climate change and greenhouse gas (GHG) emissions.
- Identification of sustainability challenges concerning the transport of goods utilizing primary and secondary data.
- Generation of recommendations concerning the long-term transformation of the transportation sector.

1.3 Thesis Structure

This dissertation consists of six chapters. The introductory chapter lays out research rationale, aim and objectives. The second chapter investigates relevant literature concerning sustainability in relation with road freight operations, setting focus on Germany and Portugal. The section methodology encompasses the election of research approach, design and strategy. Chapter four of this research includes four case studies with a focus on sustainability efforts – two companies from Portugal and two companies from Germany. The fifth chapter evolves around the research findings, derived from two sources: 1) the case studies, and 2) the qualitative questionnaires. The final chapter includes the limitations of this research, the conclusion derived from the findings, as well as recommendations concerning future research. Additional information, complementing the research topic and allowing a deeper insight, can be found in the appendices.

CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

This chapter has the purpose to illustrate diverse viewpoints on sustainability and road freight. The utilized literature covers various subject areas that are relevant in order to understand the correlation of climate change and the transportation sector and its practices within the transportation of goods. These set the basis to analyze the development of the road freight sector with the aim of identifying challenges and possible solutions towards sustainable development within the operations.

The literature reviewed is based on a list of articles compiled through the keyword search of 'road freight' and 'sustainability'. This ensures the suitability of the articles towards the subject matter. A list of 51 articles was extracted from Scopus, a database of abstracts and citations based on peer-reviewed literature (Elsevier, 2020). In order to gather data efficiently, the author decided on filtering the articles by their abstract. This leads to a narrowed and more precise identification of relevant data[1]. The first screening identified 23 articles contributing towards this research. In the second screening the articles were processed in depth and categorized into themes addressing sustainability challenges and insights, guiding the thematic division of the subchapter sustainability challenges and insights[2]. The filtered articles were mostly composed in English – one in Portuguese. The need for legislative information and country specific data lead to another search of literature. Additional data was derived from governmental organizations, statistical databases, peer reviewed and scholarly articles, academic books and non-profit organizations. These publications combine to a number of approximately 30. These sources contained German as well as Portuguese data.

2.2 Sustainability and Sustainable Development

Amongst others, over-exploitation of resources and overpopulation are causing the change in climate leading to several consequences such as e.g. abnormal variations to the climate, loss in biodiversity, and the increase of the global surface temperature. These need to be considered and require humanity to reassess the economic and societal growth to improve the utilization

[1] View Appendix A: First Screening Scopus List.
[2] View Appendix B: Identified Themes and Second Screening Scopus List.

of energy and raw materials. Thus, sustainable development targets exactly those challenges. In order to implement and advance sustainable development, policies, strategies and standards need to be taken on (Sloan, Chen, & Legrand, 2017).

The world commission for development and environment, Brundtland Commission, has started using the term 'sustainable development' in 1987. It can be defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (International Institute for Sustainable Development , n.d.). To foster sustainable development three spheres have to be considered: economic, societal and environmental.

2.3 The Transportation Sector and its Environmental Impact

The flow of goods on a specified transportation network for road, maritime and air can be defined as freight transport. The transportation sector consists of various industries, among others: road, rail, airlines, and marine (OECD, 2020). When discussing transport, it has to be considered that it can be divided into three sub-categories:

- *Total transport* comprises national as well as international transport. It focusses on the goods loaded; goods unloaded along with cross-trade.
- *National transport* implies the transport of goods within a country, including the aspects of loading and unloading.
- *International transport* can be easily derived from the previous definitions and concerns the goods that are loaded and unloaded in diverse countries (Eurostat, 2019).

This study will focus on total road freight transport, including national and international transport with a focus on Germany and Portugal.

By keeping the suns heat within the atmosphere greenhouse gases are escalating the temperature on earth. Human activity contributes massively towards this development. CO_2 is the main component of GHG, amounting to 64% of global warming, followed by methane with 17% and nitrous oxide with 6% (European Commission, n.d.). Since CO_2 has the main share of GHG, it will be within the main focus of this study. Road transportation is responsible for about two thirds of CO_2 emissions in the transportation sector, from which about half of it is related to road freight (Chapman, 2007).

Within their assessment of CO_2 emissions of heavy-duty vehicles, the International Energy Agency (IEA) has displayed various figures explaining the road freight industry. It has become clear, that the transport oil demand is heavily correlated towards the trucks and their operations - it has resulted in 80% of the total oil demand growth between 2000 and 2015 (International Energy Agency, 2018). In addition to that, road freight is responsible for approximately 20% of the activity of goods (t/km) and after passenger cars in second place concerning oil utilization used for medium freight trucks and heavy freight trucks (European Commission, 2018).

In order to receive an overview of the road freight sector, it is of importance to identify the vehicle stock, implying the number of vehicles operating. Although the definitions and regulations on international level vary, the freight vehicles can be divided into three main categories: Light Commercial Vehicle (LCV) typically up to 3,5 tons, Medium Freight Truck (MFT) from 3,5-15 tons and Heavy Freight Truck (HFT) greater than 15 tons (International Energy Agency, 2018).

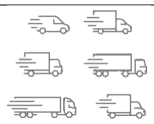
The International Energy Agency has published different views of statistical data concerning the worldwide vehicle stock. Thus, this research sets focus on the figure global stock of road freight vehicles, 2015. The total vehicle stock in 2015 accounts for about 160 million operating trucks. The majority of trucks falls into the category of LCV's with a share of about 75% from the total, followed by MFT's with about 16% and HFT's with approximately 10% (International Energy Agency, 2018). With 31,6 million vehicles North America has the largest truck fleet, closely followed by Europe with 31 million. China positions in the third place (27,4 million) and Latin and South America in the fourth place (20,2 million) (International Energy Agency, 2018)[3].

Since Germany and Portugal have a special relevance for this research, a closer look will be taken at European road freight and its statistics. The data provided by Eurostat (2019) displays that in 2018, 4,3 million freight vehicles were registered (therefore operating) in the European Union (EU). This number varies from the total number given by the International Energy Agency. As no specific correlations to the freight categories can be identified, it is assumed that the number mentioned on the statistics website of the European Commission excludes the LCV's. The number of freight trucks in the EU has increased by 5% from 2014 until 2018, adding up to a number of 4.3 million. The highest share of the registered EU vehicles

[3] View Appendix C: Global Vehicle Stock.

has Poland with 15,8% Germany is second with 12.6% followed closely by France with 12.5%. With its 80,276 vehicles, Portugal contributes a share of 1.9% to the EU total (Eurostat, 2019).

Table 2.1. EU Vehicle Stock – A Focus on Germany and Portugal. Reprinted from road freight transport by vehicle characteristics by Eurostat, 2019(https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_freight_transport_by_vehicle_characteristics#Vehicle_fleets).



EU Vehicle Stock

4,3 million

	
Vehicles Germany	***Vehicles Portugal***
545,635	80,276
Vehicle Growth Rate (2014-2018)	***Vehicle Growth Rate (2014-2018)***
+9,1%	-19%

Looking at the growth rate of the countries vehicle stock it can be identified that the countries with the highest decrease were Norway (-25%), Portugal (-19%), and Italy (-15%). The countries increasing their fleet by a significant amount were Ireland with 42.1%, Romania with 36.7% and Slovenia with 23.4% (Eurostat, 2019). The age of the vehicle is of relevance, as the CO_2 emissions increase in advanced years, due to mileage, the obsolesce of the technology and deterioration. Eurostat has found that 60.8% of the absolute number of kilometers driven are operated through vehicles that are five years and fewer, whilst 20.2% were performed by trucks over 10 years (Eurostat, 2019). When it comes to the empty running's concerning total transport in the EU the majority of countries received a percentage share of 15% to 30% in vehicle-kilometers.

Figure 2.1. displays road freight transportation in million ton-kilometers of five European countries, also including Germany and Portugal. The time span from 1998 to 2018 shows that Portugal has stayed below 50 thousand t/km, whereas Germany until 2008 and within 10 years has climbed from 250 thousand up to almost 350 thousand t/km. 2018 shows that the value has decreased to about 320 thousand t/km (OECD, 2020).

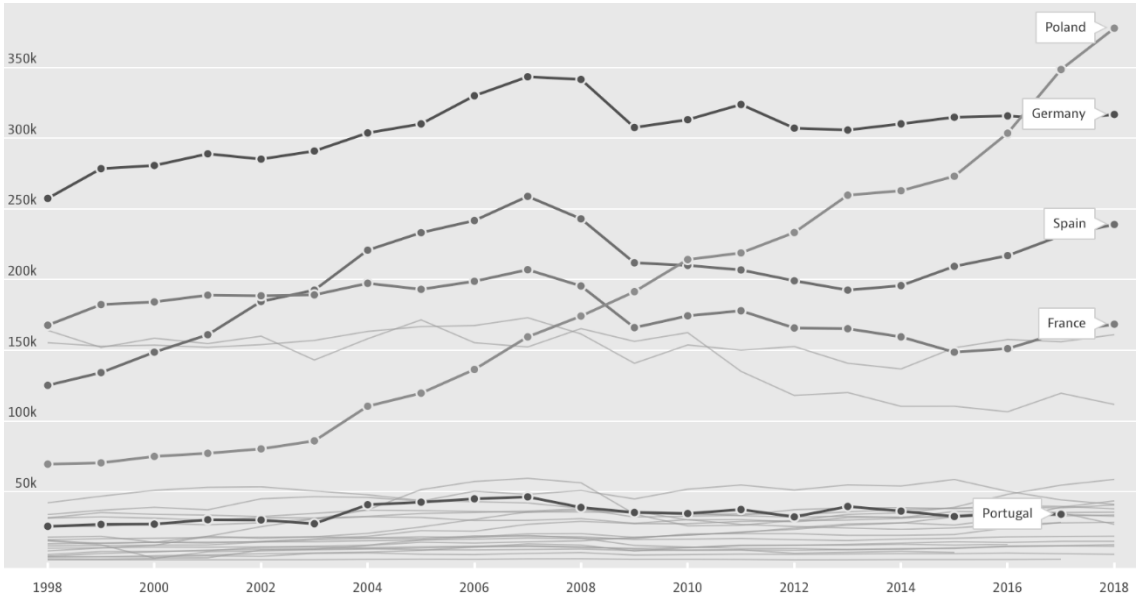


Figure 2.1. Road Freight Transport in million ton-kilometers (1998 – 2018). Reprinted from Freight transport by OECD, 2020 (https://data.oecd.org/transport/freight-transport.htm).

The IEA has developed a scenario focusing on the sustainable development of the road freight sector - the Modern Truck Scenario. Here it is the target to focus on three pillars (improvement of efficiency, logistics and alternative fuel) in order to reduce emissions by up to 75% and the trucks demand in fuel by 50% by 2050 (European Commission, 2018).

2.4 Sustainability Challenges and Insights

This section is based on the articles mainly derived from the Scopus database based on a key-word search. The main identified themes evolve around: freight operations, freight infrastructure, information and communication technology, and regulations/administrative policies.

2.4.1 Freight Operations

Since transport can be viewed as a highly important factor of the supply chain, in 2010 Sanchez-Rodrigues et. al, with a focus on the United Kingdom, have researched the effect of uncertainty in logistics on sustainable transport operations. This study was based on McKinnon's sustainability framework, linking supply chain processes with CO_2 emissions within the transport operations (Sanchez-Rodrigues, Potter , & Naim , 2010). The researchers found that uncertainty in the supply chain impacts the environmental and economic performance of

transport operations. The results display that uncertainty in the sector is related to four factors 'delays, demand and information issues, delivery constraints and insufficient supply chain integration' (Sanchez-Rodrigues, Potter , & Naim , 2010). Another factor heavily influencing the operations of i.e. retail and grocery is uncertainty coming from traffic congestion; as it leads to disruptions in the supply chain. The authors have identified that delays and delivery constraints affect factors such as empty running and average load on laden trips. The authors advise that in order to mitigate uncertainty in their operations, and utilize resources more efficiently, these four mentioned factors need to be analyzed and processes developed accordingly (Sanchez-Rodrigues, Potter , & Naim , 2010).

Sanchez Rodrigues, Piecyk, Mason, & Boenders (2015) state, that the need for longer and heavier vehicles in Europe has been rising, especially for heavy and cumbersome goods. It has to be clear that there are positive as well as negative impacts when it comes to the amplification of the vehicle. An interesting fact stated by the author is that the majority of European countries allow a vehicle length of no more than 18.75 meters (Sanchez Rodrigues , Piecyk, Mason , & Boenders, 2015).

The researchers have studied the attitudes of logistics providers, in the geographical range of Germany, towards the adoption of longer and heavier vehicles. Freight consolidation implies shippers using the same container for transport, in order to reduce environmental impact and operational costs through longer and heavier vehicles. The empirical findings of the study display that there are positive and negative effects concerning the consolidation of freight in longer and heavier vehicles. The consolidation of freight in LHV's does not have an impact on infrastructure investment and vehicle safety. Positive impacts of freight consolidation would signify decreased levels of traffic in turn reducing costs of accidents, traffic congestion, and fuel consumption; implying lower levels of carbon pollution. Furthermore, the cost of operations for shippers would decrease, making the use of rail transport less favorable, thus leading to a potential negative effect concerning the reduction of emissions: the increase in freight demand (Sanchez Rodrigues , Piecyk, Mason , & Boenders, 2015).

Wehner (2018) is looking at the concept of capacity utilization in order to improve energy efficiency and stimulate sustainable development. The author states that the advancement of information and communications technology (ICT) will not be sufficient to reduce the transport sectors energy consumption and could also identify that current literature mainly focusses on the increase of the laden weight (Wehner, 2018). The interviews conducted by the author lead to results laying out a framework consisting of actions, parties and operation processes in the

transport sector leading to unutilized capacity and will be elaborated on in the following paragraphs.

The actions leading to unutilized capacity are divided into three levels: Transport, warehousing and transshipment. Proposed mitigation strategies in the transport level include deliveries during non-peak times, vehicle routing to improve efficiency, and utilization of full freight hold to operate less trucks. At warehousing level, the author suggests standardized boxing schemes and earlier packaging and labelling. The transshipment level can reduce the environmental impact through the utilization of ICT to improve the flow of information, collaboration of shipments, and usage of a marketplace to reduce empty running (Wehner, 2018). The parties are divided into the levels of logistics service provider, shipper and end-consumer. In the first level the recommended mitigation strategies imply the usage of electric vehicles for urban freight, transportations services from logistics service providers instead of retailers themselves, and electronic bookkeeping. The second level suggests mitigation in form of emission reporting and the increase in time of the delivery period. Mitigation concerning the end consumer can evolve around transparency concerning the carbon footprint of the transport industry, as well as consumerism and its effect (Wehner, 2018). To conclude, the author could identify that there is not sufficient support and tools when it comes to the calculation of the carbon footprint of a company. Wehner (2018) also criticizes that 'costs are not an appropriate indicator for measuring environmental impact'.

The authors have conducted a literature review concerning sustainable road freight transport with a focus on intervention mechanisms; which can be recapitulated as a way or instrument to improve occurring operational provocations (Kumar, Tob-Ogu, Cullen , & Ballantyne , 2018). Kumar et. al (2018) could identify themes concerning the about 100 reviewed articles where clear preferences concerning the number published by topic appeared. The intervention mechanisms found are based on themes divided into the key-topics identified:

1. ICT – improvement of efficiency, technology for emission reduction
2. Decoupling – implementation through policies, and analysis of its impact
3. Modality – positive effects of uni-, co-, synchro- and inter-modality
4. Operations – implementation of strategies like vehicle routing and alternative fuel
5. Policy – instruments, regulations and measures
6. Others - urban freight, freight corridors and congestion planning

About 75 percent of the reviewed articles can be categorized into the themes operations, policy and modality. Concerning the theme of decoupling, it was identified that the available literature does only correspond to the geographical range of Europe (Kumar, Tob-Ogu, Cullen , & Ballantyne , 2018).

Oberhofer and Fürst (2012) have researched the view of the Austrian transport sector concerning their practice and implementation of environmental management. It is the objective to determine differences within operations and strategies of the companies represented in the study. The authors argue that the implementation of sustainability efforts in an organization is in wider acceptance nowadays. The implementation can lead to a competitive advantage in the market as consumers start seeing green initiatives as more important – ideally leading to customer loyalty. Furthermore, there is a positive effect on the brand image of the organization (Oberhofer & Fürst, 2012).

The results of the research display that out of 259 questionnaire participants the majority is apprehensive concerning the high significance of the conservation of the environment. Approximately 111 companies have stated that they considered themselves actively using environmental management in their operations. This implies that the remaining 148 companies (56%) do not practice environmental management (Oberhofer & Fürst, 2012). The authors could identify a correlation of the companies practicing and not practicing environmental management towards the size of the company. It seems that larger companies are the ones active in environmental management, whereas the smaller ones belong to the category of not practicing environmental management. This can be because they ‘are usually exposed to higher economical and market pressures’ (Oberhofer & Fürst, 2012).

To improve environmental management performance the implementation of certifications can be beneficial. Approximately 36% of the respondents are certified and have a certification concerning environmental management or quality management. Although the reason to acquire this certification was mostly correlated towards customer demand. The reason for the low participation in certification schemes can be related towards the companies not viewing it as necessary, and towards its high costs (Oberhofer & Fürst, 2012). Due to the high purchasing cost and the development stage of the vehicles, the participants view on the implementation of environmentally friendly vehicles (e.g. electric, hybrid) is negative. Only 10% of the participants have such a vehicle in their truck fleet (Oberhofer & Fürst, 2012).

Schröder and Cabral (2018) have developed a three-dimensional (3D) routing model which is based on geographical information, such as amongst others the elevation of the road, with the objective of carbon emission reduction through environmentally friendly routing of the truck fleet. Through its geographical execution in Portugal's Lisbon metropolitan area, and its focus on the distribution of goods, the findings are relevant and can contribute towards this thesis.

The authors have conducted five case studies using the 3D routing model to determine the environmentally friendliest route. When examined in contrast to the 2D model, the 3D model shows significant benefits regarding CO_2 emission and fuel savings as the weight of the vehicle and road inclination are incorporated. The for the case studies determined environmentally friendly routes, if applied, could decrease the transports carbon emissions as well as their fuel consumption by about 20%. However, it needs to be considered that the eco-friendly routes also lead to an increase in km travelled and hours travelled, affecting the costs of the operation and making it economically the least favorable route (Schröder & Cabral, 2018). On one hand Schröder and Cabral (2018) highlight, that the 3D routing model can be beneficial towards the optimization of routes, and on the other hand the authors question the sector's investment in sustainable development as the economic benefit is not clear.

2.4.2 Freight Infrastructure

The infrastructure of the road along with shippers and their truck fleet carrying the goods is of high significance to the world population. It is ensuring that the goods demanded by the customer will arrive according to their preference. Therefore, its relevance is linked towards adding value to the economy and its people (Engström, 2016). With 'population growth, urbanization, globalization, digitalization and demographic change' (Engström, 2016) the freight transport sector will need to constantly adapt and improve their operations. Advantages in the road freight sector can be summarized into flexibility concerning time management, last mile delivery, speed and capacity. Disadvantages that have been identified are environmental footprint, road safety, reliability in times of natural obstructions, and the suitability in terms of long-distance operations (Engström, 2016).

The authors conclude that the road infrastructure is not utilized in an effective way, thus they are providing a model towards its sustainable development. The 5 pillars that could lead to greener operations are: Land use planning, policy and regulations, behavior and logistics, technology/innovation and infrastructure (Engström, 2016).

In order to identify if horizontal collaboration in urban freight can reduce the environmental impact and the overall transportation costs, Ouhader and el Kyal (2017) have created a mathematical function to test that. It was found that the collaboration on horizontal level can lead to diverse outcomes and is only possible if certain ground rules have been agreed upon in order to save intellectual property and customer data. Positive outcomes can be summarized into the combination of human capital and knowledge for adding value towards product/service, reduction of costs for the transport processes (e.g. km/travelled) and shared risk (Ouhader & El Kyal, 2017).

The results display that the utilization of the collaboration concept does decrease the carbon emissions and cost of transport. Furthermore, less vehicles would need to be used, thus decreasing urban congestion. It needs to be considered that the downside of collaboration signifies the decrease of employment (Ouhader & El Kyal, 2017).

Schulte and Ny (2018), argue that due to the zero-emission system electric vehicles have gained relevance and support. Nevertheless, other stages in the life cycle of the electric vehicle are affected by heavy emissions (Schulte J., Ny H., 2018).

When thinking about trucks and electrification it is difficult to imagine how much of the already rare raw materials would be required to transform the entire fleet into an electric one. Through the constraints concerning metals like cobalt and lithium, that seems unimaginable (Schulte J., Ny H., 2018). Thus, another approach is the transformation and electrification of the infrastructure; more concretely the road. Electric road systems (ERS) can be ‘defined as roads that support dynamic power transfer from the road to vehicles while the vehicles are in motion’ (Schulte J., Ny H., 2018). ERS can be categorized into three sub-categories: overhead lines, road based inductive, road based conductive (McKinnon, 2018). By reason of the available data and the stage of technological development Schulte and Ny (2018) specifically focus on overhead lines. The research elaborated that the electrification of roads could positively affect sustainable road transport due to the effect of its decrease in the life-cycle stage of the battery manufacturing, longevity, and chargeability.

There is a positive impact on the battery size – keeping it at a comparably small size, thus utilizing a similar amount of raw materials used for conventional electric vehicles. Whilst on a dismounted ERS, depending on the length of road that has been built, a truck could increase its charging level by nearly 150 kilometers. This is especially useful for the road freight sector (Schulte J., Ny H., 2018).

The end results of the study display that sustainability, and its favorable outcome in transport are strongly relying on the production of electricity. Thus, implying that the promotion of green energy is required in order to achieve new development in the sector of electric transport, specifically in ERS's. Additionally, the long-term implementation needs to be looked at – due to the high investment in the infrastructure, it would have to be used for a long period of time (also because of its environmental effectiveness), without sufficient funding there would not be any development, and if the transportation network is not sufficiently developed there is no reason for the industries to invest into more expensive new technology (Schulte J., Ny H., 2018).

2.4.3 Information and Communications Technology

Daviesa, Masona, & Lalwanib (2006) developed a thesis concerning the impact of ICT on the haulage operations of the road freight sector in the United Kingdom (UK). In the transport of consumer goods via road, the supply chain has adopted processes such as the lean strategy, thus achieving shorter lead times and enhanced material movement. This implies, that it has become more effective concerning 'flexibility, speed and directness' (Daviesa, Masona, & Lalwanib , 2006). The authors have identified four existent challenges in the UK transport industry: international competitors, deficiency of truck drivers, road congestion and the EU legislation Working Time Directive. In theory these can be improved by utilizing ICT (e.g. automation cuts costs, improvement of infrastructure). The results of the study show that the controlling interest of the UK transport fleet believe that ICT has a positive impact on their operations. Furthermore, it was found that associations categorized as small (vehicle fleet number of 11 and less), are in the last spot concerning ICT adoption (Daviesa, Masona, & Lalwanib , 2006).

Wang, Sanchez Rodrigues, & Evans (2015), highlighted that in the UK number one CO_2 contributor, with 92% of total emissions, comes from domestic freight transportation. As ICT can be an instrument to improve the road freight operations, the differentiation between on-vehicle technology and in-house systems is crucial.

In order to determine how the implementation of ICT could impact the transport sectors carbon footprint, the researchers have conducted a case study with three retailers from the grocery sector. The study was divided into four levels of ICT utilization: 1. vehicle and load, 2. company, 3. supply chain and 4. network (Wang, Sanchez Rodrigues, & Evans, 2015). The results display, that diverse systems have been applied in the previously mentioned levels for ICT usage, with a focus on the first two levels. Here tools such as pre-delivery check systems

and transport management systems (planning & scheduling and execution & tracking) are applied, mainly focusing on on-vehicle technology, thus the reduction of fuel consumption and adaptation of the truck driver's driving style. Further insights display, that levels 3 and 4 set their focus on the efficiency within operations, therefore tending to put aside the force it has on the environment. In order to further reduce the environmental footprint, ICT in form of integrated networks and collaboration is necessary in levels 3 and 4 (Wang, Sanchez Rodrigues, & Evans, 2015).

2.4.4 Regulations/Administrative Policies

Alises and Vasallo (2015) argue that economic activity has impacted and directed the increasing need for road freight. Phenomena such as globalization, internationalization, technology and digitalization have affected the consumers by increasing their demands towards products and services concerning quality, price and availability.

Within the past years transport within the European Union has 'accounted for around a third of all final energy consumption (…), and more than a fifth of greenhouse gas emissions' (Alises A., Vassallo J., 2015). It has also been identified that the positive development of the GDP and international exchange have a correlation towards the advancement of the demand and utilization of road freight. The researchers conducted a study where opposing road transport and economic development to analyze how the process of decoupling those two factors can generate positive results concerning sustainability within the sector (Alises A., Vassallo J., 2015).

The results of the study display that the development, concerning the strategy of decoupling, has divergent levels in Europe. Out of nine analyzed countries, seven countries 'tonne-kms grew at almost the same rates or even higher rates than gross domestic product (GDP) between 2000 and 2007' (Alises A., Vassallo J., 2015). The study identified three positive outcomes of decoupling road freight and economic activity: 1. The transformation towards a service directed industry can reduce the demand in goods, thus transportation. 2. Logistics and manufacturing processes can be optimized through the implementation of ICT. 3. The need of the supply chain system to transform its entire operations towards efficiency (Alises A., Vassallo J., 2015).

The European Green Deal (EGD) was created by the European Commission, with the intention to tackle climate change and initiate the transformation towards sustainability and

resource-efficiency (European Commission, 2020). The subjects that are in the epicenter are the elimination of GHG emissions by 2050, the process of decoupling the demand for goods and services from economic growth, and that 'no person and no place is left behind' (European Commission, 2020). Ursula von der Leyen presents the EGD as 'our new growth strategy – for a growth that gives back more than it takes away' (European Commission, 2019).

The EGD is a guideline that comprises diverse actions, including policies and measures, needed for the conversion of the EU towards a sustainable future, focusing on seven main subject areas: clean energy, sustainable industry, building and renovating, sustainable mobility, biodiversity, from farm to fork, and eliminating pollution (European Commission, 2019). Sustainable mobility is the key policy area relevant to this dissertation, although its development is correlated towards clean energy. Thus, it is crucial to progress the energy system and market through digitalization and interconnectivity towards a renewable energy market (European Commission, 2019). The reduction of the carbon footprint in this area is relevant, as the utilization and production of energy accounts for 75% of the EU's GHG emissions.

To advance the sustainable development of the mobility sector in the EU, the end user should be the focus of attention for mobility providers. Through the improvement and innovation of services the end user can be directed towards sustainable means of transportation (European Commission, 2019). Diverse subject areas are addressed by the European Commission that are relevant when it comes to reaching climate neutrality. In order to reach this target, the transportation sector needs to decrease its carbon footprint by 90% by 2050. The subject areas concerning sustainable mobility include:

- A significant increase of multimodal transport to commence the shift of inland freight from road to rail and water.
- Development of sustainable solutions and systems to improve automation, stimulating the improvement of congestion and pollution in urban areas.
- Adaptation of the transportation prices towards the environmental impacts the mode of transport has.
- Increase of manufacturing and distribution of alternative transport fuels.
- Decrease of the carbon footprint, especially in urban areas (European Commission, 2019).

2.4.5 Other Insights and Challenges

Zeit (2020) published that in 2023 a brand will commence building trucks with hydrogen fuel cells. This would enable to cover a distance of 1000 kilometers and more. Daimler announced that they are planning a joint venture concerning the manufacturing of hydrogen fuel cells. Around September 23rd the organization has introduced its first hydrogen truck prototype (Lamparter, 2020).

Challenges and difficulties with the implementation of hydrogen trucks are related to the high cost of the power units when only small numbers are produced. Additionally, the fuel station network is not sufficiently developed for the efficient establishment of hydrogen powered vehicles (Lamparter, 2020). An advantage compared to the battery electric vehicles are the light weight of the gas and the time of refueling/ charging. The cost of the hydrogen power units is about four times more expensive than another combustor (Lamparter, 2020).

McKinnon (2018) lists the advantages and disadvantages of the hydrogen operating trucks. The author also states that the infrastructure of hydrogen gas filling stations is not given. In addition to that would the purchase of a truck be costly, as the storage space of the gas is four times higher than the one of diesel. An advantage of the hydrogen truck would be the ability to deploy them for heavy and long-haul operations.

When speaking about the utilization of batteries in vehicles, there are three different options: internal combustion engine, hybrid vehicle and plug-in hybrid vehicle. The benefit of these technologies is that they are matured in their development. Due to the fact that the cost of the battery would increase according to the range of the truck, it would only prove beneficial for urban and short distance operations (McKinnon, 2018).

Natural gas trucks produce slightly lower emissions than petrol and diesel fuel options, although they are still reliant on fossil fuels. There are two main options of gas: Liquid Petroleum Gas and Compressed Natural Gas. Another option are Biofuels; these are produced from renewable plant material and oil. There are two different versions biodiesel and bioethanol. The material is mixed with fuel, either ethanol or diesel, to make it usable (McKinnon, Cullinane, Browne, & Whiteing, 2010).

When reviewing the numbers of electric and hybrid electric cars registered in the European Union, it can be seen that in 2013 approximately 300 thousand cars have been registered. 2017 shows that this number has multiplied by seven, up to about 3 million (European Commission, 2019). The hybrids using electricity and petrol include three quarters of the cars that have been

registered in 2017. Additionally, the increase in this category has been tremendous: from 250 thousand in 2013 up to 1,5 million in 2017 (European Commission, 2019).

When comparing the European average conventional car and the average electric, differences in the structure of the life cycle can be observed. Electric vehicles create more emissions in the process of manufacturing because of the battery as a component within the process. The extraction of valuable and rare raw material, such as lithium, utilized for the production of the battery is linked to the high CO_2 emissions (The International Council on Cean Transportation, 2018). When considering the factor of the tailpipe, it can be said that the gasoline used as fuel, accounts for the highest amount if CO_2 emissions in a conventional car.

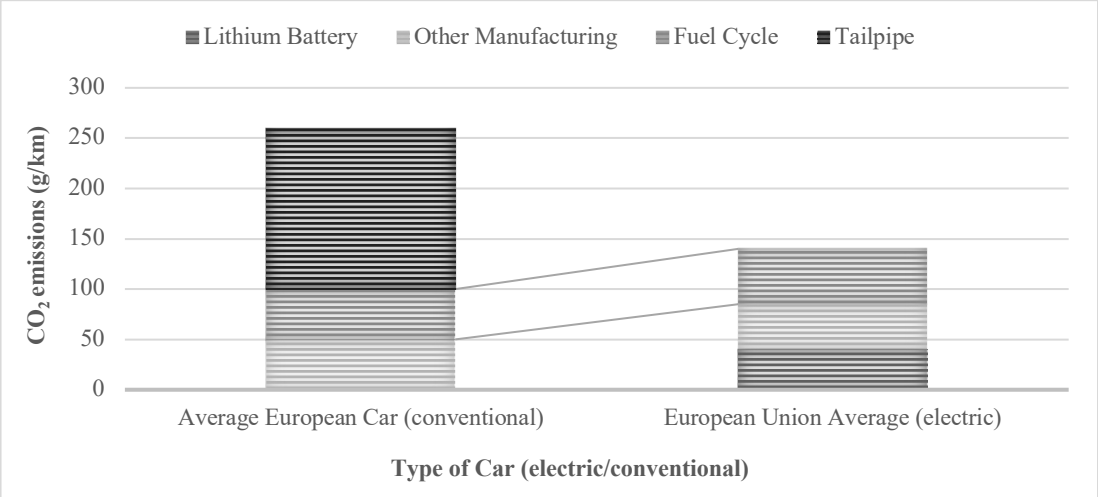


Figure 2.2. Life-cycle emissions (over 150,000 km) of electric and conventional vehicles in Europe. Reprinted from Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions, by The International Council on Clean Transportation, 2018, p. 5.

To conclude, there are negative and positive aspects about both of the vehicle models but the life-cycle emissions for the European Union average electric car are significantly lower than the ones of the conventional car. 'An average electric vehicle in Europe produces 50% less life-cycle greenhouse gases over the first 150,000 kilometers of driving' (The International Council on Clean Transportation, 2018).

2.5 A Comparison of Transport: Germany and Portugal

In order to display a clear picture of the transport sector in the two countries, quantitative data in form of statistics will be displayed. These will lay out certain factors to be able to compare

Germany and Portugal concerning their past, present and future development in relation to sustainability.

2.5.1 Germany: An Overview

In 2019, 33.1% of the electricity production in Germany were derived from renewable energy sources, with wind as the leading one (Statistisches Bundesamt, 2020).

Statistisches Bundesamt (2019) has tracked the commercial transport for Germany. The first look at the results shows that road freight, as a mode of transport, contains the highest number of tons transported, followed by rail (with significant difference), marine, inland marine and air freight. The amount of transportation via air freight has decreased from 2012.

From 2012 up until 2018 the amount of goods transported by road has been increasing continuously, by approximately 500,000 (in 1,000 tons). This increase needs to be considered strategically. The trucks that are in use in the country until 1,499 tons load capacity 96% rely on diesel, 3% on petrol and 1% alternative drives. The trucks with 1,500 tons and more load capacity have a similar distribution, with 99.7% reliant on diesel (Eurostat, 2015).

Table 2.2. Amount of goods transported by mode of transport (Amount of goods transported in 1,000 tons). Reprinted from Statistisches Bundesamt: Güterverkehr, by Statistisches Bundesamt, 2019 (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Road_freight_vehicle_statistics_-_lorries,_road_tractors_and_trailers&oldid=221855).

Year	**Mode of Transport:**					**Total**
	Rail	Road freight	Marine (inland)	Marine (sea)	Air	
2012	366,140	3,286,700	197,904	299,562	4,935	4,175,452
2013	373,738	3,362,100	222,731	294,869	4,847	4,261,029
2014	365,003	3,489,500	221,349	291,987	4,546	4,387,477
2015	367,314	3,494 ,900	221,369	291,823	4,401	4,379,808
2016	406,933	3,601,800	228,489	300,120	4,397	4,526,615
2017	412,121	3,682,500	226,864	293,999	4,315	4,617,068
2018	416,635	3,746,600	223,170	295,103	4,317	4,665,636

Environmental Targets

In the year 2016, the country has committed to the Climate Action Plan 2050, in accordance with the Paris Agreement. It is the target to be GHG neutral by 2050 (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, n.d.)

In Germany the study of the Umwelt Bundesamt (2016) has elaborated, that the emissions in road freight transport can be reduced by about 25%. To reach the reduction value, the country focusses on the optimization and relocation of road freight transport. To be able to do so, it has to be identified why there is such a high demand in the transportation of goods by road in order to tackle it and minimize it. Since road freight is the linking element of manufacturing and consumption, politic-economic process needs to be controlled and redirected (Umwelt Bundesamt, 2016). Here it needs to be considered that 15% of the demand goes towards consumer goods, especially comestible goods that are required for the population. Approximately 25% of the goods can be categorized as stone, ore and soil mainly coming from the construction sector. Excluding comestible goods, the German populations lifestyle will be redirected through the following subject areas and concrete measures. Furthermore, the country intends a shift towards rail freight, as it is not as environmentally damaging in terms of its carbon footprint.

This study will focus on the measures taken concerning road freight:

- *Market access and market regulation* sets focus on the transport of goods by rail and includes indications for road freight:

    - Introduction of longer trucks up to 25 meters that are only allowed to drive on a certain road network (Umwelt Bundesamt, 2016). The target of this measure is to reduce the mileage by optimizing the capacity and thus the quantity delivered. It is forecasted that this strategy will bring 15% to 20% of savings in fuel and efficiency improvement. (Bundesministerium für Verkehr und digitale Infrastruktur, 2020).
    - Furthermore, there is the intention to further loosen the regulations on outsourcing transport to country external providers. This is supposed to improve the degree of capacity utilization (Umwelt Bundesamt, 2016).

- *Economic instruments and fiscal policy* consider the taxation policies of road freight. Here the tolls for trucks are the main course of action for reduced emissions:

    - The measures taken concerning trucks are the escalation of road user charge with consideration towards the vehicle's levels of consumption, inclusion of further vehicle sizes, and the expansion of the network. Through the expansion of the toll network there would be an increase in the costs of operating, which is supposed to

stimulate the optimization of the transport, thus saving mileage and improving the capacity utilization (Umwelt Bundesamt, 2016).

- The *regulatory policy* includes regulations and limitations concerning the execution of road transports:

    - The implementation of environmental zones within urban environments impacts the operations of road freight, again regarding the trip optimization. It stimulates the need for the industry to look for alternative technologies.
    - Furthermore, incentives for alternative driving mechanisms, comparable to the environmental zone system, will be introduced (Umwelt Bundesamt, 2016).

- *Financial promotion and subventions* in Germany focus on the transport by rail, as it is targeted to increase productivity for rail and develop a cost benefit in comparison to road transport:

    - Monetary benefits when using systems of combined transportation to relocate the transportation of goods from road to rail. This will help increase the operation opportunity of rail services (Bundesministerium für Verkehr und digitale Infrastruktur, 2020).

- *Infrastructure politics* will be stimulated through the cooperation with financial institutions to create capacity increasing effects focusing on freight by rail:

    - Electrification of large routes utilizing diesel to improve operations.
    - Increase the speed for the rail network in order to obtain a faster connection and more trip capacity. This will improve the reliability and the projectability of the trips made.
    - Implement a constant operation for longer trains to increase productivity (Bundesministerium für Verkehr und digitale Infrastruktur, 2020).

- *Area- and traffic planning* sets focus on the processes within transport.

    - To improve urban logistics planning tools in form of ICT can be introduced to improve processes in different stages. This improves the transport operation itself.

    - The advancement of the regional economy can have an effect on processes like production and supply. Through that the distance the product travels could decrease.

- *Information politics and the creation of awareness* targets the industry to improve processes within their logistics and manufacturing system.

    - Through the introduction of an energy label for trucks, the criteria that need to be fulfilled by the vehicle itself are identified. Thus, limiting the trucks able to operate and possibly stimulating the idea of outsourcing (Bundesministerium für Verkehr und digitale Infrastruktur, 2020).

Although multiple qualitative targets, as previously listed, have been set and recorded in Germany, freight transport has no existent quantitative binding targets set concerning air pollution emissions at a federal level (Umwelt Bundesamt, 2016). It has to be mentioned that various sectors have to observe targets on a national level.

2.5.2 Portugal: An Overview

With its steady development in among other things, its renewable energy sources, and the improvement of its carbon footprint, Portugal has achieved a high rank concerning sustainability. 42% of the electricity production in Portugal were derived from renewable energy sources, with wind as the leading one (State of Green, 2019).

Concerning its infrastructure for transportation (with focus on road freight) it can be stated that as of 2016, the Portuguese road network has reached a length of 14,313 kilometers. The road freight sector in Portugal contains approximately 7,800 organizations with about 50,000 operating vehicles. 85% of those companies operate with up to nine vehicles in their fleet (Comité National Routier , 2015).

Regarding freight transportation, the numbers presented by the National Institute for Statistics in Portugal display that freight by rail, road, maritime and air in 2016 has developed differently from 2012 levels concerning tons of goods transported and tons-kilometer transported. Whilst the modes of transportations that are used on land have decreased, the sectors air and maritime have increased over the years (Instituto Nacional de Estatística, 2017).

The amount of goods transported via road has decreased by 4% from 2015 to 2016[4], and rail has reduced its level by 6.3%. However, the tons-kilometer of transport have increased by 3.2% for rail and 6.6% for road. The goods transported via road freight vary on the type of traffic-national, international entry and international exit. Nationally the most transported good is refined oil, the most goods leaving the country are base metals closely followed by secondary raw material, the international goods entering the country are agricultural and fish products. The consumption of fuel within the road freight sector has increased by 0.1% adding up to 5.35 million tons of oil with diesel being the preferred type of fuel in the country. Within Portugal, 64% of the total movement of goods (in tons) is focused on routes of transportation concentrated in the northern and central regions of the country (Instituto Nacional de Estatística, 2017). National transportation company's main destination concerning the delivery of goods is the neighboring country Spain with 31.3% in t/km. Closely behind is France with 25.7%, Germany with 15.6%, the UK with 8.7% and Italy with 6.9% (Instituto Nacional de Estatística, 2017).

Environmental Targets

In 2016 the Portuguese government has committed to become carbon neutral by 2050. The increase of emissions from 1990 by 29% to 78.0 metric tons Carbon Dioxide Equivalent (CO_2e) in 2017 is another reason for the efforts towards an environmental economy. The country follows international and European framework concerning the carbon reduction, such as the Paris Agreement[5]. To be able to achieve the environmental targets Portugal has set up the 2050 Carbon Neutrality Roadmap. It addresses all existing industries, and asks for support concerning innovation and the increase of efficiency in operations, with a special focus on the transport- and electricity generation sector (Governo da República Portuguesa, 2019). Portugal's target is the reduction of its carbon emissions, compared to 2005 levels, of 18-23% by 2020, and 30-40% by 2030. Furthermore, the roadmap identifies the acceleration of the development of renewable energy sources in form of wind and water. Additionally, it is contemplated that natural gas replaces oil and petrol products. The country is convinced that 'climate policies can go hand in hand with economic growth, job creation, people's health and the environment' (Governo da República Portuguesa, 2019).

[4] View Appendix D: Goods Transported, by Mode of Transport.

[5] Paris Agreement: International environmental target of maintaining the overall temperature rise within the next one hundred years beneath 2 degrees Celsius and even constrain it to 1.5 degrees Celsius.

The following paragraph will include concrete strategies for the transport sector relevant towards the accomplishment of the 2050 targets set by the government. In its report, the Portuguese government displayed that transport has been one of the highest emitters; with 25% of the country's total emissions. The growth of the sector has been tremendous over the past years. Road transport in the country accounts for 96% of the total transport emissions. When speaking about transport, the government combines passenger and freight transport (Governo da República Portuguesa, 2019).

Concrete plans to reach the 2050 target include investment towards public transport and the development of its infrastructure – referencing to metro and rail. In addition to that, the country wants that total transport energy consumption by 2050 is distributed to 70% electric vehicles to 30% combustion engines. It is believed that the trend of electrification among consumers will bring that shift, especially when the energy generation is based on renewable energy sources (Governo da República Portuguesa, 2019). The use of hybrid vehicles for the private usage will support the reduction of emissions in the transport sector. For the reduction of emissions concerning long haul, biofuel will be of relevance. Autonomous mobility serves as a counterpart to electric vehicles, enabling the increase of efficiency concerning capacity utilization with the concept of the sharing economy. The government expects further developments in alternative fuels such as hydrogen and ERS. It is highlighted that the advancement of those alternatives depends on the coherent investments and the costs of developing and operating this infrastructure (Governo da República Portuguesa, 2019).

The power generation sector, with 29% of the total national emissions, is one of the principal components tackling the decarbonization. The country has committed to end its coal-based power generation by 2030. It is the target that renewable energy sources, especially solar and wind, produce 50% of the energy in 2030 and 70% in 2050. The government highlights that due to its dependance on natural forces, the energy production is related to challenges concerning the reliability of energy reserves (Governo da República Portuguesa, 2019).

2.5.3 Country Overview: Germany and Portugal

Table 2.3. Country Overview. Data retrieved from: Umwelt Bundesamt (2019), Eurostat (2015), and Eurostat (2018).

	Portugal	***Germany***
GDP	213.301million € (2019)	3.435.210 million € (2019)
Number of Vehicles *(lorries, road tractors, semi-trailers and trailers combined)*	1.257.886 million	9.407.627 million
Tons of Goods Transported	200 million tons (2018)	3,500 million tons (2018)
Environmental Targets	Carbon neutral by 2050	GHG neutral by 2050

CHAPTER 3 - RESEARCH METHODOLOGY

3.1 Introduction

The term research has various definitions, Saunders, Lewis, & Thornhill (2009) have defined it as a systematic approach, where data is collected and interpreted to discover phenomena and developments concerning the subject area. The focus of the definition is on the one hand the systematic approach, implying that the research is based on coherent correlations, and displaying why the gathered information is of significance. Discovering, on the other hand, means 'describing, explaining, understanding, criticizing and analyzing' (Saunders, 2009) the required data. Furthermore, the research process has different periods within its structure concerning: the explanation of the subject matter, the examination of literature, the collection of data, the data analysis and the reporting of the findings (Saunders et al., 2009).

The framework of the research onion[6], by Saunders (2009), is the foundation of the subsequent chapter. It will display the utilized research methods relevant towards the data collection of this thesis.

3.2 Research Philosophy and Approach

The research philosophy relates to 'the development of knowledge and the nature of that knowledge in relation to research' (Saunders, Lewis, & Thornhill, 2009).

The research approach can either be deductive or inductive. The process of the inductive approach commences with the collection of data to then lay out a theory. Deduction starts with the theory, meaning that the researcher gathers already existing information to then observe and confirm it (Bryman, 2016). This dissertation sets focus on the deductive approach.

3.3 Research Design

The research design 'is a plan, structure and strategy of investigation so conceived as to obtain answers to research questions or problems' (Kumar R. , 2011). Since the study aims to depict the cases of Luís Simões (LS), Paulo Duarte Transportes (PD), trans-o-flex (ToF), and BLG Logistics (BLG), it possesses features of descriptive research (Saunders, Lewis, & Thornhill, 2009). Through the search of literature in the field of sustainability developments and

[6] See Appendix E: Research Onion.

challenges in the road freight sector, as well as the distribution of questionnaires it also has features of exploratory nature (Saunders, Lewis, & Thornhill, 2009).

3.4 Research Strategy

Bryman (2016) defines research strategy as a sense of direction concerning the handling of the research itself. The research strategy utilized and applied by the researcher can be either qualitative or quantitative. While the quantitative strategy relies on significations acquired from numbers and results in findings in form of numerical data, the qualitative strategy is based on words and the collection of information established through categories (Saunders, Lewis, & Thornhill, 2009). Thus, the quantitative strategy implies the utilization of questionnaires and structured interviews, whereas the qualitative method corresponds to the semi-structured and unstructured interviews as well as focus groups (Saunders et al., 2009; Bryman, 2016).

Difficulties would arise in the gathering of numerical data concerning CO_2 emissions of the road freight sector. This is due to the fact that the measurements of GHG's vary from company to company, as there is no standardized process for it. Furthermore, the reliability of the quantitative data is questionable, as organizations set value on their brand image; thus, possibly presenting oneself in a better light. Therefore, this dissertation will apply the qualitative research strategy.

3.5 Method for Data Collection

When it comes to the collection of data, there are two methods utilized to find information about the subject matter (Kumar R. , 2011). The primary data collection indicates that the information comes from its first source, being of original nature. The secondary data collection implies that the required data is available and needs to be filtered by the researcher (Kumar R. , 2011).

3.5.1 Secondary Data Collection

The sources that can be categorized as secondary data include journals, books, newspapers and governmental publications (Saunders, Lewis, & Thornhill, 2009). Saunders (2009) highlights, that the research question and the set objectives are highly relevant towards the conduct of the literature review.

The chapter containing the literature review is based on secondary data. The articles retrieved through the keyword search on Scopus are referred to as academic journals, implying

that they are written by experts in the field (Saunders, Lewis, & Thornhill, 2009). Amongst others, the Journal of Business, Journal of Transport Geography and the International Journal of Logistics Management were utilized. The data gathered concerning the transportation sector and its environmental impact, the EGD, and the country specific information comes from governmental publications, academic books and statistical databases.

The case studies were prepared using secondary data. The publicly available documents that organizations provide on their websites can be identified as official documents from private sources (Bryman, 2016). Among others, annual reports and press releases are utilized for the collection of data. The sustainability report derived from the organizations websites was the basis for the compilation of the case studies. Bryman (2016) states that the researcher needs to consider that the person composing a document, has a specific point of view. This indicates, that the information collected cannot certainly be identified as objective. The author categorized the findings to display the case studies in a coherent way[7].

3.5.2 Primary Data Collection

There are diverse methods for the primary data collection. The most popular modes for the qualitative data collection are the unstructured interview, the semi-structured interview and focus groups (Bryman, 2016). Another option for the collection of qualitative and quantitative data is the questionnaire. As the focus of the data collection are personal insights and opinions of specific logistics and transport professionals the self-administered questionnaire seems suitable.

The self- administered questionnaire via email was selected due to various reasons. Kumar (2011) states that the geographical position of the study population is a reason to choose the questionnaire, since the travel costs spent for face-to-face interviewing can be high. In addition to that, the author states that the anonymity of the respondents can be guaranteed. It is helpful for the collection of data, especially when addressing sensitive subjects (Kumar R. , 2011). Due to the sample distribution across Germany and Portugal, as well as the fact that sustainability within an organization can still be seen as a sensitive subject, the self-administered questionnaire was suitable. The selected sample was very specific evolving around the transport and logistics industry. In addition to that, with sustainability in focus, only particular people in certain organizations would be able to answer the composed questions. Saunders, Lewis, &

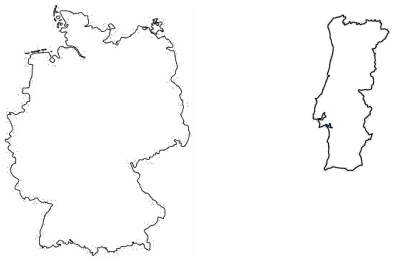
[7] See Appendix F: Thematic Categories Case Studies.

Thornhill (2009) state, that the need to reach a specific person as a respondent is a reason for choosing the questionnaire as a mode for the primary data collection. The compilation of the questions for the self-administered questionnaire[8] took place in accordance to the literature reviewed. The questionnaire comprises 14 open - and closed-ended questions setting a focus on environmental sustainability. A maximum of 15 minutes would be needed to complete the distributed questions.

The selection of the sample was based on nationally operating medium-sized transport and logistics organizations in order to ensure comparability. Through contacts in the university network, the Portuguese companies Luís Simões and Paulo Duarte were the starting point for the distribution of the questionnaires. The given contact ensured their response. The selection of the German case studies was made in accordance to the Portuguese. Since the transport and logistics organizations from the two countries needed to be comparable, the author had to develop a definition of comparability. It was calculated with three elements relevant to the transport operations:

- total population of the country,
- the country area in km^2, and
- the total length of the existing roadways.

*Table 3.1.*Factor Calculation. Data retrieved from: Central Intelligence Agency (2020) and Central Intelligence Agency (2020).



	Germany	**Portugal**	**Factor**
Population	80,159,662	10,302,674	7.78
Total km²	348,672	91,470	3.81
Total Road Length	625,000	82,900	7.54

Since the element of total population is correlated towards the demand and the purchasing power of the country, it is of importance concerning the calculation of the factor. The total area

[8] See Appendix G: Questionnaire Master – PT/GE road freight companies.

in km^2 as well as the length of the roadways was selected as it is the base for the transport sectors operations. With the comparison of the respective elements from Portugal and Germany a factor could be determined.

The average factor of the three elements represents 6.38 and is also considered as the maximum factor. The minimum factor was set at 1. These factors display the baseline for the selection of German cases, based on LS number of vehicle combinations and employees. Also, the sectors of activity were part of the selection criteria in order to ensure comparability.

Table 3.2. Definition of Comparability. Calculation by author, 2020.

	Vehicle Combinations	**Employees**
Min. Parameters for German Cases **Numbers of Portuguese Case, Luís Simões**	~ 2.100	~ 2.370
~ Max. Parameters **for selection of German companies**	13.392	15.114

The next step was the identification of suitable and comparable German companies. The study 'TOP 100 der Logistik 2018/2019' by the Fraunhofer Institute was utilized as a guide to find German organizations. From about 100 companies, 38 seemed suitable at first glance. Looking at the vehicle combinations, number of employees and sector of activity, the author was able to categorize them into three categories (not suitable, moderately suitable, suitable)[9]. Five companies were identified as suitable. The sector of activity and number of vehicles and employees of BLG and ToF appeared to be most suitable towards LS. Furthermore, information on sustainability efforts, and potential interview partners via LinkedIn were given. Thus, the above-mentioned organizations were selected as German case studies for this dissertation.

To reach the required response rate, the questionnaire was distributed as a writable pdf to make the answering process as uncomplicated as possible. The companies were approached through various channels: email, LinkedIn and contact form on the company websites. The response rate was zero concerning the attempts of contact via LinkedIn. Also, the response rate

[9] See Appendix H: Categorization of 'TOP 100 der Logistik'.

via email and contact form was limited, which is why the organizations needed to be approached and reminded via telephone. The process of gathering the data took about 6 weeks.

As an addition to the transport organizations, the author decided to add the input and expertise of a research organization with a focus on mobility. The Fraunhofer Institute, of German origin, specializes on research concerning new technologies and innovation. Thus, it seemed suitable. The questionnaire was adapted to receive a general view on the subject matter, comprising only 10 of the 14 initial questions[10].

3.6 Data Analysis

The basis of the data analysis is correlated to the case studies and the questionnaires. Due to the qualitative nature of the research, the author decided on using the thematic analysis. This implies that the researcher selects themes relevant towards the reviewed literature and the established research questions. Suggested by Bryman (2016), the themes have been applied in the case studies and questionnaires.

Through the identification of themes, the author was able to ensure comparability on the companies' efforts towards sustainability. Similarities and differences in sustainability approaches could be identified for the case studies.

The categories chosen for the questionnaire are closely related towards the research questions. They are setting focus on the challenges of the road transport industry, measures already implemented to enhance the sustainability performance and the EGD.

3.7 Trustworthiness of the Research

When it comes to qualitative research, the evaluation of the acquired data is based on two main components 1) trustworthiness and 2) authenticity. Trustworthiness is sub divided into four elements: credibility, transferability, dependability and confirmability (Bryman, 2016).

When considering the credibility of this research the utilization of good practice is in focus. To ensure credibility, this dissertation applied the concept of triangulation. It means that multiple sources of data are used to cross-check the findings that were derived (Bryman, 2016). The sources of data used in this dissertation include the case studies, the literature reviewed and the distributed industry questionnaires. Transferability corresponds to the ability to reflect the

[10] See Appendix I: Questionnaire Template Research Institute.

findings onto other social settings. Although it may be difficult to generalize the findings of qualitative research (Bryman, 2016). Dependability entails that the research process is documented and recorded properly. This dissertation documented the data collection within its methodology. Furthermore, can the questionnaire master, as well as the participant responses be reviewed in the appendix. This enables readers to follow the process of the data collection and the analysis. Confirmability means that the research has been conducted objectively. Thus, not including the personal values of the researcher (Bryman, 2016).

3.8 Ethical Procedures and Challenges

A challenge concerning the questionnaire respondents was correlated with the fact that knowledge regarding the sustainable development of the organization was required. This was relevant towards the quality of the data gathered. The job position of the respondent is of importance as well, as the view on the subject matter is related towards the field of activity. Hence, the researcher decided on contacting sustainability managers and marketing and public relations representatives. Since the response of the industry specialists was required towards the development of this dissertation, and only limited contacts were available, the author needed to adapt to existing resources. Time was identified as a constraint concerning the collection of additional data in form of the questionnaires.

Ethics conjoined with the research process implies the correct handling of the information provided by the selected sample (Saunders, Lewis, & Thornhill, 2009). The focus is set on voluntary participation, anonymity and treating the data confidentially. This dissertation followed the above-mentioned ethical procedures.

CHAPTER 4 – CASE STUDIES

The aim of a case study is to describe the subject matter in detail (Saunders et al., 2009; Bryman, 2016). The utilization of multiple cases enables the researcher to identify similarities and differences; thus, ensuring comparability (Bryman, 2016).

The objective of the following chapter is to lay out multiple cases (4), to gain an overview on their business operations. The first two cases, Luis Simões and Paulo Duarte Transportes, are displaying Portuguese transport providers. The other two, BLG Logistics and trans-o-flex, are German.

All of the displayed cases will include a company description, information on the business operations and their strategies towards sustainability.

4.1 Luís Simões

4.1.1 Company Description

The business of Fernando Luís Simões has commenced in 1948, when him and his wife acquired a heavy-duty vehicle in order to offer transportation services for goods. Until this day in time, the organization is family owned and now under the control of Chief Executive Officer José Luís Simões of the second generation. The core business evolves around logistics and transportation. It is one of the leaders within road freight operations on the Iberian Peninsula (Luís Simões, 2018).

LS consists of 10 companies providing logistics services, transport services, and services including reta, diagonal insurance and promotional logistics. Its main sectors of activity include food, automotive, consumer electronics and retail. The company has 3 technical support centers, 24 logistic operation centers, 9 transport operation centers and 11 co-packing centers, based in more than 40 locations (Luís Simões, 2018).

4.1.2 Business Operations

Due to its operations in the Iberian Peninsula, LS has various facilities in Spain and Portugal. In 2019 the organization has had a total of 2,370 employees. About 84% of these employees are occupied with tasks concerning road transport of goods and logistics. LS owns storage areas of approximately 350,000 square meters and a truck fleet comprising 2,100 vehicles (Luís Simões, 2017). The operating trucks and the drivers handle 960 transport routes per day, travelling more than 140 million kilometers per year. Furthermore, the organization transports

goods in form of food, automotive, beverages, consumer electronics, and fashion of about 123 million tons per year. The growth of the organization has been significant over the past 10 years, as the number of logistics centers has doubled (Luís Simões, 2019).

Within its growth strategy, the organization sets its focus on entrepreneurship, innovation, and sustainability. In the year of 2019 a 1.9% growth of turnover was recorded compared to 2018 levels, reaching 245 million Euros (Luís Simões, 2019).

4.1.3 Strategy towards Sustainability

The organization provides the public with an annual sustainability report, which is available on the company website. The report is manufactured considering the guidelines of the Global Reporting Initiative. With input from its stakeholders, LS is constantly developing strategies towards sustainability within its operations. In accordance to the sustainable development goals, the company has set up 9 principles to enhance its processes (Luís Simões, 2019):

1. To supply high quality service
2. To advance processes concerning energy efficiency
3. To permanently educate and involve employees
4. To improve and promote road safety
5. To ensure economic stability
6. To promote innovation
7. To promote safety and health at the workplace
8. To promote internal and external citizenship
9. To promote internal and external communication

A special focus is set on principles one to four. Various initiatives were implemented in order to make the business and its operations more sustainable such as, amongst others, the total transition towards digitalization.

Economy

LS has set up a code of conduct applicable to its workforce. Furthermore, a zero-tolerance policy concerning bribery and corruption is in place (Luís Simões, 2019).

Environment

Emissions:

LS has commenced a project that intends to account the GHG's that the company emits. Results show that in 2017 the organization has recorded CO_{2e} of 42,101 tons. In 2018 LS set focus on parameters having an effect on the emissions and was able to reduce them by about 83 tons CO_{2e}. To visualize the reduction the CO_{2e} can also be translated into three trucks weighing 24 tons each. The organization states that it was able to further reduce those levels in 2019 (Luís Simões, 2019).

Table 4.1. Luís Simões CO_2 emissions and reductions. Reprinted from Sustainability and Account Report, by Simões, Luís, 2018.

	Annual Emissions of LS Group in CO_2e (direct and indirect sources)	**Achieved Reduction to next reporting year**
2017	42,101 ton CO_2e	83.7 CO_2e
2018	41,454 ton CO_2e	1,313 CO_2e

Vehicles:

Overall, the company owned vehicles are on average no more than 2.5 years old and mostly have the Euro standards five and six. The entire truck fleet has reduced its GHG emissions by 16% over the last decade (Luís Simões, 2018). As a pioneer concerning sustainability in the Iberian Peninsula, LS has been working towards the improvement of efficiency in their operations. This can be identified by the introduction of the first gas truck as well as their efforts to regularly update their truck fleet. The organization has introduced heavy duty trucks in 2014 and was able to record improvements of 30% concerning CO_2 emissions by ton transported. The reductions in CO_2 emissions result in operating efficiency due to lower operating costs and less fuel consumption (Luís Simões , 2018). At this point in time the organization possesses 10 Giga Liner combinations in use in Portugal and Spain to stimulate the European Modular System. It is a concept setting focus on combinations of already existing elements designated for loading purposes in order to increase efficiency. The combination of a truck with two trailers allows a length of 25.25m with a total loading weight of up to 60 tons, which is one third more than a conventional truck could carry. With the utilization of Giga liners a possible reduction of 144 tons CO_2e per year can be achieved (Luís Simões, 2019).

Buildings:

Furthermore, the organizations Cabanillas warehouse in the Madrid region has been the organizations first center built according to sustainability standards. Through its architecture and usage of technology, such as solar panels on the roof of the building, the operations at the Cabanillas warehouse could reduce 8% of their electricity utilization and 40% of water consumption (Luís Simões, 2019). For their Leadership in Energy and Environmental Design, LS has received the LEED Gold certification [11] (Luís Simões, 2018).

Driving Behavior:

Over the past 10 years, LS has run a program that helps the employed drivers towards the development of more eco-friendly driving behavior. This promotes the subsidence of GHG during the driving operations. In 2018 the organization has introduced new mechanisms to further improve their operations and integrate their fleet management tools with their transport management system. In comparison to 2017 GHG emissions the eco-driving project has contributed towards a reduction of 21.9% to 2019 levels (Luís Simões, 2019).

Certifications:

In order to improve operations towards sustainability, LS has obtained various certifications considering its operations. 39 of its centers concerning logistics and transport operations have the ISO 9001 certification implying requirements for a quality management system. 16 of the centers are certified with ISO 14001, which is considered as enhancement of its environmental performance (Luís Simões, 2018). The Safety and Quality Assessment for Sustainability (SQAS) certification has been obtained by the organization for its Portugal operations and ensures safety and quality concerning the transport of dangerous goods (Luís Simões , 2018). Luís Simões has received the gold ranking from EcoVadis[12] (Luís Simões , 2019).

[11] LEED certification: Leadership in Energy and Environmental Design, a green building certification.
[12] EcoVadis: Ranks environmental and social performance of a company.

Social

Concerning the aspect of *diversity,* LS workforce consists of 70% males and 30% females. Although it needs to be considered that compared to 2017 figures there has been a 22% increase of females working at the organization. The Board of Directors is occupied by 43% females (Luís Simões, 2019). *Safety and health* initiatives concerning the workforce are addressed through workshops and trainings (Luís Simões, 2019). With the opening of the Cabanillas warehouse, the organization was able to show social commitment and create employment positions for the local community. In 2019, 236 workers were active at the warehouse (Luís Simões, 2019).

4.2 Paulo Duarte Transportes

4.2.1 Company Description

José Paulo Duarte has commenced his business in 1946. Now the organization is led by the third generation of the Paulo Duarte family, with its headquarters in Torres Vedras, Portugal (Paulo Duarte, n.d.). The main business of the organization concerns national and international transport services. PD offers a variety of services, such as the transportation via general load, food liquids, dangerous goods, controlled temperature, link trailer and e-commerce. The organizations specialization lies in the transportation of liquids, and goods in bulk (Paulo Duarte, n.d.). Besides its headquarters, the organization has three further locations in: Azambuja, Perafita and Lamego (Paulo Duarte, n.d.).

4.2.2 Business Operations

The organization carries out its operations in Europe and is able to offer transportation services in 15 countries. At this point in time, Paulo Duarte has approximately 730 employees, of which 85% are operating as drivers (Paulo Duarte, n.d.). The truck fleet of 1,179 vehicles travelled more than 44 million kilometers in the year of 2018. The fleet consists of 500 motor vehicles, 6 gas vehicles and 673 trailers. With its operations in 2018, the company was able to generate a turnover of 49 million Euros (Paulo Duarte , n.d.)

4.2.3 Strategy towards Sustainability

The information concerning PD’s efforts towards sustainability, was exclusively extracted from the company’s website.

Economy

Under the section ‘management policy’ on their website, the organization states being committed towards ‘labour laws (…) in accordance with the principles of non-discrimination, freedom of expression and association, business ethics, free competition and anti-corruption, fraud and money laundering practices’ (Duarte, 2020).

Environment

Vehicles:

In 2019, PD has bought 5 trucks that use natural gas as fuel. This serves the organization on the economic level, as the costs are similar to the ones of regular fuels, and on the environmental level, as it reduces the impact on the nature (Paulo Duarte , 2019). The average age of the entire truck fleet is about 3 years old. Furthermore, 95% of the utilized trucks correspond to the Euro 5 and Euro 6 standards (Paulo Duarte, n.d.). The company has acquired three link trailers in the year of 2018. They have a 55% higher load capacity, thus reducing the CO_2 output. The maximum capacity amounts to 38 tons (Transportes Paulo Duarte , 2018).

Certifications:

To advance its business operations towards sustainability, PD has various certifications in place. Three of them belong to the ISO certifications, one concerns the quality management system (ISO 9001), the second the environmental management system (ISO 14001), and the third regarding the management system for safety and health at work (ISO 45001). In addition to that, the SQAS certification has been obtained concerning its transport services, as well as its tank cleaning activities (Paulo Duarte, n.d.).

Social

Training and education of the PD employees is embedded in the organization’s strategy.

4.3 trans-o-flex

4.3.1 Company Description

In the year of 1971, trans-o-flex was founded through the congregation of five shipping companies in Germany. The company name is derived from the words ‘transport organization of special flexibility` (DVZ Redaktion , 2019). Today, the organization is controlled through the Chief Executive Officer Wolfgang P. Albeck with company locations and a workforce located in Germany and Austria. The transport operations are conducted from 84 company

locations, in 36 countries in Europe comprising elements of B2B and B2C (trans-o-flex, 2018). Trans-o-flex is the umbrella brand for the three business segments: pharma logistics, technology logistics and contract logistics. The main sectors of activity include pharma, cosmetics and consumer electronics. Furthermore, the organization specializes in sensitive and high-quality commodities (trans-o-flex, 2018).

4.3.2 Business Operations

In the year of 2018, the organization has had 2,040 employees, of which 1,923 were employed in Germany and the remaining 117 in Austria. The truck fleet of the company comprises approximately 2,900 vehicles. B2B operations continue to be the main focus of the trans-o-flex group, although more and more B2C deliveries are included into the operations portfolio (trans-o-flex, 2018). Since the pharmaceutical industry is one of the organizations main clients, the transport of the products needs to be in a specific temperature range. Thus, the specialization in cooling transportation was relevant, enabling transports from 2-8 degrees Celsius and 15-25 degrees Celsius within Europe. Within the cooling transports, as well as its transports for its other clients, the organization has conveyed its flexibility, safety and promptness in the operations (trans-o-flex, 2018). The main field of work at trans-o-flex evolves around the handling of the transportation loads. Through the addition of diverse company locations, the size (by number of employees) of the organization compared to 2012 levels has increased by about 75% in 2018. In the year of 2018 the group has achieved a turnover of 468 million Euros (trans-o-flex, 2018).

4.3.3 Strategy towards Sustainability

Trans-o-flex provides an annual sustainability report available over its website. The report is based on the three pillars of sustainability: economy, environment and social.

Economy

In order to ensure economic sustainability, ToF has set up a code of conduct, applicable for the organization as a whole. It comprises standards concerning the administration of the organization bound upon the UN Global Compact (trans-o-flex, 2018). Including behavior in ‘the company and towards business partners and the public’ (trans-o-flex, 2018).

Environment

Driving Behavior:

Courses of instruction are given to the trans-o-flex drivers for the purpose of driving fuel efficiently. However, the influence concerning contracted transport drivers cannot be assured. Additionally, the organization is going to implement various software solutions to record incurring emissions (trans-o-flex, 2018).

Emissions:

In the year of 2018 the CO_2 emissions of the organization made up a total of about 109 thousand tons, which is a 15% reduction compared to 2016 levels. Responsible for 18%, thus 19.650 tons of CO_2, are the organizations own activities (scope 1) and the purchased energy (scope 2). The remainder of the accumulated emissions comes from the transport services allocated to independent parties (scope 3). The main reductions of emissions from 2016 were recorded in scope 3 (trans-o-flex, 2018).

Vehicles:

ToF has about 3,000 vehicles conducting transport operations on a daily basis. In the year of 2018, the vehicles have covered a distance of 215.61 million kilometers. LCV operations make up 61% of the conducted transport operations. The number one originator of the carbon footprint in transport operations is owed to the delivery of the product followed by the heavy freight trucks in the area of collection and line operation (trans-o-flex, 2018). Within the transport operations, the vehicles are responsible for 92% of the accumulated GHG. 8% come from administrational activities, business trips and the storage and handling of goods (trans-o-flex, 2018). About 72% of the truck fleet correspond to the Euro 5 and Euro 6 standards. The organization is working towards the renewal of the fleet, with a large investment in 2018, and 200 new vehicles. To further reduce emissions, trans-o-flex is using tools for route planning (trans-o-flex, 2018). In July of 2020, despite its skepticism, ToF has commenced a two-year test run concerning electric vehicles. At their location Hamm-Rhynern the model Work L from Streetscooter will be utilized for express transports (trans-o-flex, 2020).

Certifications:

ToF is certified with the quality management system ISO 9001 and the environmental management system ISO 14001. Furthermore, regular audits take place at its 84 locations to

determine its energy efficiency. Those correspond to the Eurocode EN 16247-1 (trans-o-flex, 2020). The organization has also achieved a silver rating from EcoVadis.

Buildings:

About 94% of the energy utilized at the ToF locations comes from renewable energy sources (trans-o-flex, 2020).

Customer Offer:

ToF provides the project, co$_2$de-green' to support its clients and their carbon footprint. It is the target to compensate the accumulating CO_2 emissions from transport operations through the acquisition of certificates. These are used for projects concerning clean water in Thailand, and clean energy generation in China (trans-o-flex, 2020).

Social

As elaborated above, trans-o-flex employs 2,040 workers. Concerning the aspect of *diversity,* the percentage of males and females has to be looked at. Overall, almost 75% of the organization are men, whereas 25% are female. This is due to the fact that most areas of operations require high physical effort. Looking at the rate in the office operations, the female quote is at 44.6%. A variety of cultures can be identified among the employees, counting personnel from 51 nations (trans-o-flex, 2018). Concerning the *equality of opportunity* at the organization, it can be said that middle and top management positions in 2018 are occupied by 22,1% females – doubled compared to 2014 numbers (trans-o-flex, 2018). To ensure *worker satisfaction,* the company fosters and promotes transparency and options for professional development. Furthermore, a focus is set on flexibility concerning the employees working hours so that a good work-life balance can be met. *Safety and health* measures include workshops and trainings (trans-o-flex, 2018).

4.4 BLG Logistics Group

4.4.1 Company Description

65 merchants have founded the Bremer Lagerhaus Gesellschaft (BLG) in the year of 1877. Due to its location, transportation via seaport has been in focus. Nowadays the organization is led as a private enterprise with the municipality of Bremen as its main shareholder. The

headquarters of the company are still located in Bremen. Since 2013, Frank Dreeke holds the position of Chairman (BLG Logistics, 2019).

The organization holds a strong operational position in the German market, and operates internationally in Europe, America, Africa and Asia with over 100 company locations (BLG LOGISTICS GROUP AG & Co. KG, 2020).

4.4.2 Business Operations

BLG offers logistics services in the following areas: container, automobile and contract. The container division belongs to EUROGATE, which is a joint venture, thus is not considered in the sustainability report. The automobile division is responsible for the handling, storage and distribution of vehicles. The contract division specializes in regular logistics operations with goods including sportswear, food and consumer electronics (BLG Logistics, 2019). In the year of 2019 BLG has had an average workforce of 11,720 people at its locations worldwide. This number includes the employees of the container division. Approximately 83% of the employees are based in Germany and spread over the 70 company locations (in the contract and automobile division) (BLG Logistics, 2019). In the financial year of 2019, the group's total sales added up to 1.16 billion Euros. The automobile and contract division make up for 80% of the sales volume (BLG Logistics, 2019).

Table 4.2. BLG Group Sales by Division. Reprinted from Financial Report 2019, by BLG Logistics, 2019.

Sales by segment (€ in thousand)	**2019**
Automobile	603,734
Contract	563,934
Container	282,304
Reconciliation	-291,340
GROUP TOTAL	**1,158,632**

4.4.3 Strategy towards Sustainability

As a publicly listed company, BLG has the responsibility for transparency in its operations. Thus, the company has an annual sustainability report available over its website.

Economy

Concerning the subject of compliance, the organization has set up a code of conduct as well as an anti-corruption guide, applicable for the entire workforce. These are available as separate documents. In addition to that, the company provides their employees with regular trainings concerning compliance. BLG ensures that their suppliers and service providers are committed towards the United Nations Global Compact (BLG Logistics, 2019). Furthermore, the organization sets focus on the economic value creation of its operations towards employees, shareholders, public authorities and its loaners. Customer satisfaction and long-term business relations towards clients in combination with the optimization of processes is in focus at BLG (BLG Logistics, 2019).

Environment

Emissions:

To measure the organizations accumulating emissions three scopes were defined according to the Greenhouse Gas Protocol. Scope 1 concerns the direct emissions produced through diesel, petrol, gas and heating oil. Scope 2 includes indirect emissions such as the production of electricity, and Scope 3 contains further indirect emissions. In 2019 BLG produced 84,984 tons CO_2e, of which about 52% are related to Scope 1, 35% to Scope 2 and the remaining 13% to Scope. Compared to the emissions accumulated in 2017, the organization could reduce their GHG footprint by 9% (BLG Logistics, 2019).

Energy:

In 2019 the total energy consumption amounts 250 million kilowatt hours. 52% are related to the automobile division, with 32% linked to the transport of cars. The remaining 48% are correlated to the contract division and concern trade and industry logistics. Concerning the energy sources, diesel has the highest energy consumption followed by natural gas and electricity (BLG Logistics, 2019).

Vehicles:

In 2019 the automobile and contract division have 211 own trucks at their disposal, which are indicated in the emission calculation. 99.5% of the fleet correspond to the Euro 6 standard. It has to be considered, that transport operations supported by subcontractors have not been included but will be in future reports (BLG Logistics, 2019). Further appliances in their

inventory include the more than 600 trailers in different sizes enabling a higher load capacity (BLG LOGISTICS, 2020).

Employee Awareness:

To create awareness concerning environmental sustainability among employees, multiple trainings with the subject energy took place (BLG Logistics, 2019).

Buildings:

In 2019 the subject of lighting was in focus. This implies the complete change to LED lighting. Furthermore, the implementation of controllable technology, such as motion sensors and daylight regulation, is contemplated. Other measures include the utilization of photovoltaic systems on the roofs of warehouses. One is in place in Kelheim, where 42,000 kWh electricity could be won. This corresponds to an avoidance of 20 tons CO_2e. Another system is planned for Cuxhaven. Additionally, the location in Hamburg plans to become a Zero Impact Terminal (BLG Logistics, 2019).

Driving Behavior:

To make driving environmentally friendlier, the drivers are supported through automatic gear shift through the utilization of a software. Driving data is collected (e.g. consumption levels) to give the drivers grades concerning their driving style. Eco-trainings take place to ensure fuel efficient driving (BLG Logistics, 2019).

Certifications:

The majority of BLG's locations are certified with the quality management system DIN EN ISO 9001. Furthermore, the environmental management system ISO 14001 is in place at all of the locations from the automobile division, as well as five locations of the contract division. In 2016, 25 locations underwent the audit for the energy management system DIN EN ISO 50001 and have been certified since. EcoVadis has also tested BLG concerning its sustainability efforts and have awarded the company with the silver ranking. This signifies that BLG is among the top 25% of the tested companies, and higher than the industrial average (BLG Logistics, 2019).

Social

Concerning the aspect of *training and education* BLG offers apprenticeships and options for dual studies to help create the next generation of logistics professionals. The professional

development of their employees is also in focus, that is why the organization has provided 202 seminars and trainings in 2019. To ensure that management positions act consistently regarding their leadership behavior, BLG offers its management training 'TAKE THE LEAD' since 2017 for all of the management levels (BLG Logistics, 2019). To ensure *employee satisfaction* the organization offers flexibility concerning the working hours and sets trust in the working hours, implying no time registration. Since 2019, BLG offers their employees the possibility for a 'company bicycle'. *Health and Safety* is addressed through diverse aspects such as thorough instruction courses with machinery and equipment and workplaces that are designed ergonomically. The organization has commenced the certification process occupational health and safety ISO 45001. Through their program 'Fit& Fun' the company supports their employees visits at the fitness center (BLG Logistics, 2019). BLG employs people with different cultures and experiences from more than 60 nations. The organization has committed to the project 'Charta der Vielfalt' (charter of diversity), promoting appreciation, acceptance, and integration of *diversity* at the workspace. The organization is working hard to achieve *equal opportunities* for females. In 2019, 25.4% of the personnel were female. To continue the increase of this value the organization started a program to promote females in management positions (BLG Logistics, 2019). The *social commitment* at BLG is executed financially, as well as through the workforce's actions and qualifications, on a local level but also internationally. One example is their support of the UN World Food Programme, through the efficient distribution of food (BLG Logistics, 2019).

CHAPTER 5 - RESEARCH FINDINGS

The displayed case studies serve as a basis for transport industry related developments towards sustainability. The questionnaires enabled to gain insights and personal opinions of industry professionals on environmental sustainability. The subsequent chapters display the differences and similarities of the companies in the respective countries.

5.1 Background Information

The questionnaire participants were selected according to the identified companies in Portugal and Germany. The thematic focus of the questionnaires was laid on the environmental pillar of sustainability, specifically on the reduction of CO_2. This is due to the fact that the utilization of fuel and the transport operations make up the highest share of emissions generated.

The findings of the case study solely display the information that the organization publishes online on their sustainability efforts. The questionnaires produced findings adding value to the information provided in chapter two of this master thesis (literature review). The gathered data will lead the discussion of the research findings.

5.2 Key Findings Case Study

The findings will be derived from the German presented cases BLG and ToF, and the Portuguese companies LS and PD; based on publicly available information concerning sustainability – also with a bigger focus on the environmental pillar. Similarities and differences of the sustainability measures will be displayed.

LS, BLG and ToF are the organizations that compose an annual sustainability report and provide them as downloadable pdf documents. The author was not able to find a sustainability report from PD but could extract information from the company website.

Company Overview

Table 5.1. Overview of analyzed companies. Data retrieved from: Luís Simões (2019), Paulo Duarte (2018), trans-o-flex (2018), and BLG Logistics (2019).

	Luís Simões	***Paulo Duarte***	***trans-o-flex***	***BLG Logistics***
Employees	2,370	730	2,040	11,720
Turnover	245 million €	49 million €	468 million €	1.16 billion €
Core Business	food, automotive, beverages, consumer electronics, fashion, health, personal care, paper/pulp/packaging, retail	liquids, goods in bulk	pharmaceutical, healthcare, beauty and cosmetics, entertainment and household electronics, retail	automobiles, electronics, sports & fashion, consumer goods, food, machines, sanitary and building technology

Economic

The economic pillar is referred to as the code of conduct, either a part of the organizations sustainability report or presented in a separate document. LS and ToF have documents elaborating on the company's economic behavior including business ethics, value creation, commitment towards shareholders, business partners, customers and the surrounding society. BLG includes the topics compliance, economic value creation and customer satisfaction in the sustainability report, under the economic pillar. PD briefly states that they as an organization are committed to 'labour laws (…) in accordance with the principles of non-discrimination, freedom of expression and association, business ethics, free competition and anti-corruption, fraud and money laundering practices' (Duarte, 2020).

Environmental

To present the case studies, the author selected themes that could be identified as tools and mechanisms lowering the environmental impact of the transport and logistics sector. The themes evolve around efforts in place by the companies, aiming to reduce their carbon footprint. To compare the steps taken by the four selected companies, the author utilized the data derived for the case studies. It is of importance to consider that the statements and measurements can vary from company to company, as the published data, and the depth of it, is selected by each

company individually. Thus, comparability of the efforts towards sustainable operations is not always ensured. The selected themes are linked to the literature reviewed in chapter one.

Table 5.2. Case Study Findings- Environmental Strategies. Adapted from Luís Simões (2019), Paulo Duarte (2018), trans-o-flex (2018), and BLG Logistics (2019).

	Luís Simões	**Paulo Duarte**	**BLG Logistics**	**trans-o-flex**
	Environmental			
Emissions:	- 42,101 tons in 2017 - 2018 levels show reductions of 83 tons CO2e	/	- 84,984 tons CO2e in 2019 - reduction of 9% GHG compared to 2017 - 52% related to direct emissions(diesel petrol,gas)., 35% to indirect (electricity), 13% further indirect emissions	- 109,000 tons in 2018 - 15% reduction compared to 2016 levels - 18% (19,650 tons) related to own activities and purchased energy, remainder from transport services by third parties
Energy:	- mentions energy efficiency	/	- 2019 energy consumption of 250 million kilowatt hours - 52% related to automobile, 47% contract	/
Vehicles:	- 95% of vehicles Euro 5-6 standard (avrg. truck age 2.5 years) - 1 gas truck - 10 gigaliners 25.25m length, loading weight 60 tons	- 95% correspond to Euro standard 5&6 (avrg. truck age 3 years) - 5 trucks utilizing natural gas fuel - 3 link trailers	- 99.5% Euro 6 standard - utilization of different trailer sizes	- Truck fleet 72% Euro standard 5&6 - 215.61 million km covered - LCV make up 60% of business - number one operation processes responsible for emissions: delivery of product, HFT in collection and line operatioon - transport operations responsible for 92% of GHG, 8% from business trips and admin - Electric vehicle Work L from Streetscooter for 1 year test at one location
Buildings:	- solar pannels on Cabanillas warehouse - Cabanillas built according to sustainability standards - LEED Gold certification for leadership in energy and environmental design	/	- utililization of photovoltaic systems on the roofs of warehouses - wants to invest in renewable energy sources - plans zero impact terminals at 2 locations, with Hamburg University	- 94% of energy utilized at ToF comes from renewable energy sources
Driving Behavior:	- program for development of more eco-friendly driving behavior - integrate their fleet management tools with their transport management system	/	- automatic gear shift through software - grading system cocerning driver style - eco-trainings for fuel efficient driving	- courses and training for fuel efficient driving - going to implement in future software for emission
Certifications:	- 39 centers: ISO9001 certified -16 centers: ISO14001 certified - SQAS certification - EcoVadis - gold ranking	- ISO 9001 certified - ISO 14001 certified - ISO 45001 certified - SQAS certification	- majority of locations ISO 9001 - all automobile, 25 contract warehouses: ISO14001 - 25 locations: ISO 50001 - Eco Vadis - silver ranking	- ISO 9001 certified - ISO 14001 certified - regular audits: EN 16247-1 - EcoVadis - silver ranking
Customer Offer:	/	/	/	- co2de-green
Employee Awareness:	/	/	- trainings with focus on energy	

Social

LS, BLG and ToF have published data concerning diversity and equal opportunities at their organization. The gender distribution of females and males at the three companies is very similar in terms of the percentage of total employees.

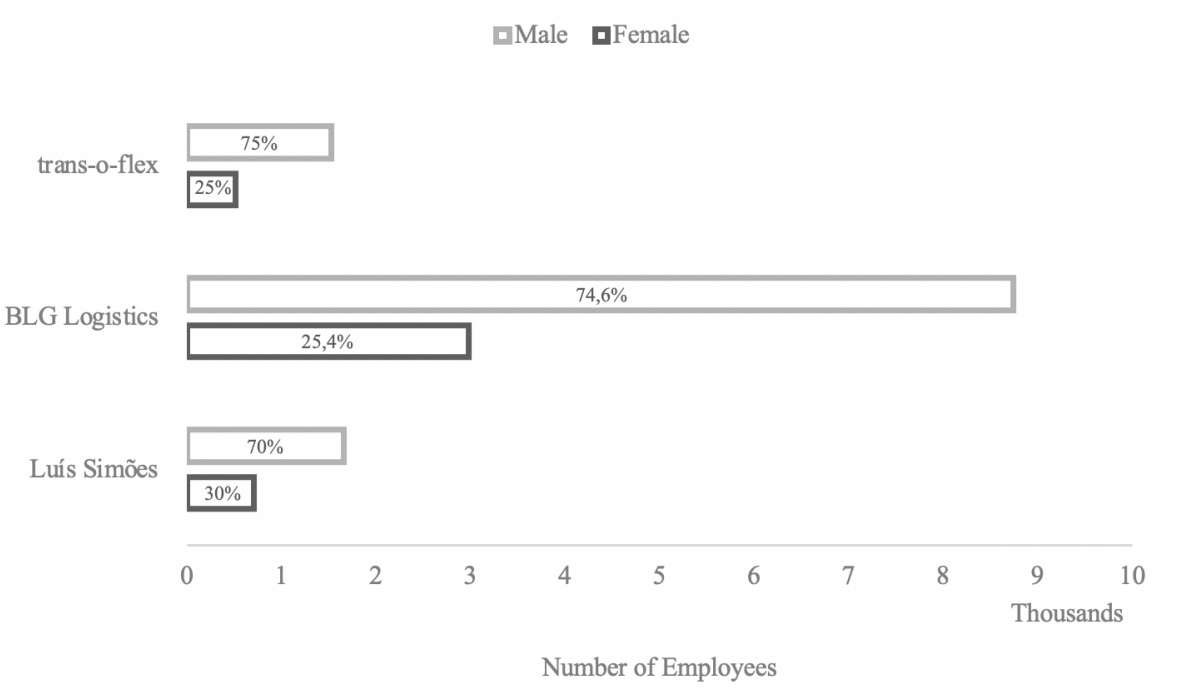


Figure 5.1. Company gender distribution by number of employees – percentage. Adapted from Luís Simões (2019), trans-o-flex (2018), and BLG Logistics (2019).

The reason for this distribution could be related to the high physical work that needs to be achieved during the operations.

The jobs that do not require high physical effort in the transport organizations have different results concerning the gender distribution. LS states that in their board of directors 43% are female. ToF displays that the allocation in their office operations is almost equally distributed, whereas in 2018 their top management consists of 22.1% females. BLG has implemented a program to enhance female leadership. Further initiatives taken are memberships at an organization promoting diversity.

Further social measures taken by the companies are listed in the following table:

Table 5.3. Case Study Findings – Social Strategies. Adapted from Luís Simões (2019), Paulo Duarte (2018), trans-o-flex (2018), and BLG Logistics (2019).

	Luís Simões	Paulo Duarte	BLG Logistics	trans-o-flex
Social				
Safety and health:	- workshops and trainings	/	- instruction courses for machinery - commenced certification ISO 45001 - Fit and Fun program for employees	- workshops and trainings
Worker satisfaction:	/	/	- flexible working hours - trust in working hours - 'company bicycle'	- flexibility in working hours - work-life balance
Social Commitment:	- creation of employment positions (Cabanillas warehouse)	/	- financial donations - workforce voluntary work - support at UN World Food Programme	/
Training and education:	/	/	- trainings and seminars for professional development - apprenticeships and dual studies (create next generation of logistics professionals) - trainings for management level	- options for professional development

5.3 Key Findings Questionnaire

An electronic questionnaire was distributed to LS, PD, BLG and ToF with the aim to achieve one response per company[13]. The questionnaire was filled in by Fraunhofer[14]. The questionnaire contains questions setting a focus on the reduction of CO_2 while one of the questions relates towards the level of satisfaction towards their company's social commitment.

Challenges in the Transport and Logistics Industry

The transport organizations and the research institute were asked about their opinion on the occurring challenges in the road freight sector. The Fraunhofer research institute stated that there is a general lack of drivers combined with the lack of young drivers. This implies a high average age among the drivers with a combination of unattractive working conditions. ToF has also identified driver shortage as one of the challenges for the transport industry.

The participant from Fraunhofer has also mentioned that the strong cost pressure and demand from the customers is a challenge the transport industry is facing. BLG agrees on this point and highlights that it will be challenging to meet customer requirements and keep pace

[13] See Appendix J for: Questionnaire Answers Summary.
[14] See Appendix K for: Questionnaire Answers Research Institute.

with the changing demands. Correlated with that, BLG identifies the difficulty of economic viability.

ToF and PD both mention fossil fuel challenges that not only concern the transport industry. The diesel driving bans can have a large impact on the operations of the organizations.

Fraunhofer also states that the transport and logistics organizations may have difficulties when it comes to the medium- and long-term investments, as there is hesitation concerning the climate policy. This statement can be related towards BLG's concerns of the industries adaptation to practices promoting environment and climate protection.

ToF states that due to the increase in online trade, the delivery traffic will increase as well. PD identified that automation processes in the industry will lead to challenges as well. Fraunhofer addresses automated driving/platooning and questions if the legislature will support the development of these technologies. This can lead to difficulties as the transport organizations have no certainty on when to start planning on implementing them.

Challenges for CO_2 reduction

Concerning the challenges in regard to the reduction of CO_2 the two German companies, BLG and ToF, identified that the dependence on fossil fuels is very high and that the alternatives are not matured. BLG elaborates on this dependence by stating the cost of an electric fleet upgrade and the sparsely deployed infrastructure.

PD mentions that the organizations investing in cleaner and environmentally friendlier equipment do not generate added value. BLG adds to this statement by saying that they see it as a challenge to implement sustainability measures with a consistent profitability. Furthermore, PD states that best practice is not incentivized through e.g. the reduction of taxes.

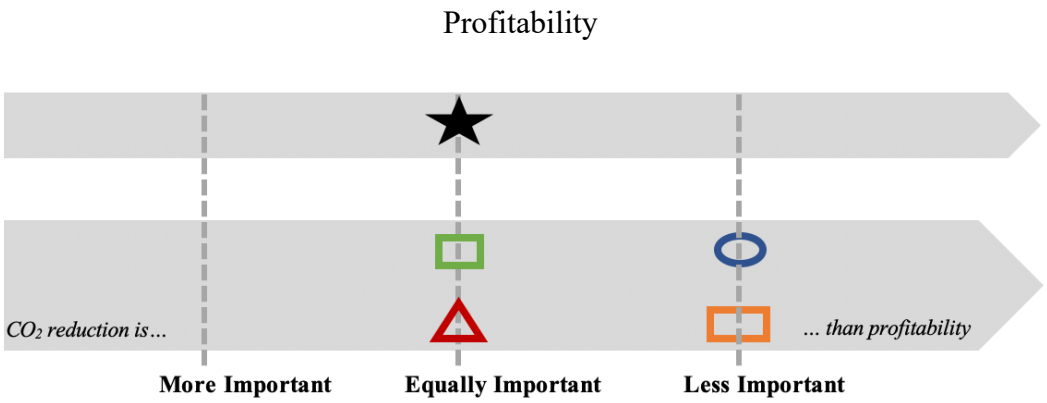
ToF mentions the increased online trade that consumers will require. This has an increasing effect on the number of transports needed. In addition to that the organization lays out that the customers cost pressure related to the service is opposed to the cost increase implied by sustainable transport.

LS highlights the importance of strategic positioning by the transport sector, as European and international policies demand a reduction of CO_2 emissions.

Importance of CO_2 Reduction for the Company

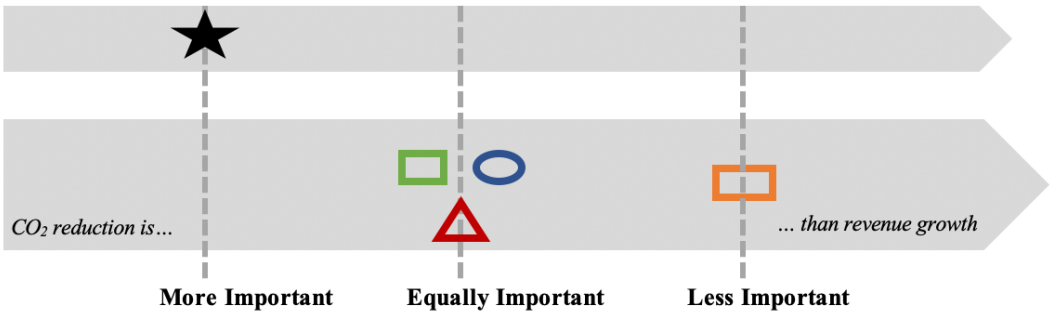
To elaborate the importance of environmental operations at the transport organizations, the sample was asked to oppose CO_2 reduction towards other factors. The answers given by transport and logistics professionals are contrasted with Fraunhofer's opinion.

Figure 5.2. Legend Symbol Assignment to Company. Composed by author, 2020.



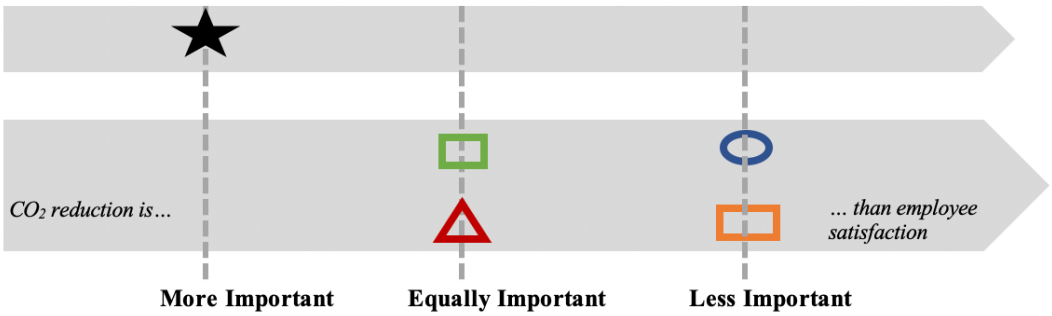
It appears that the interviewees categorize their company's profitability as more important than or equally important to CO_2 reduction. Fraunhofer's perspective is similar.

Revenue Growth



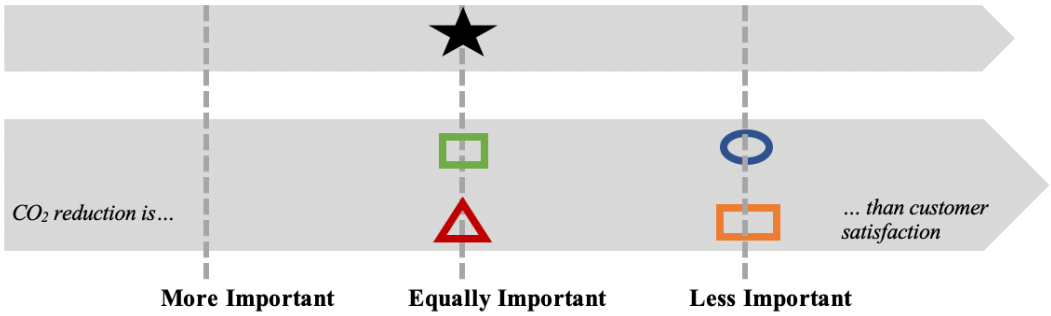
As opposed to Fraunhofer's view, it appears that the interviewees categorize their company's revenue growth as more important than or equally important to CO_2 reduction.

Employee Satisfaction



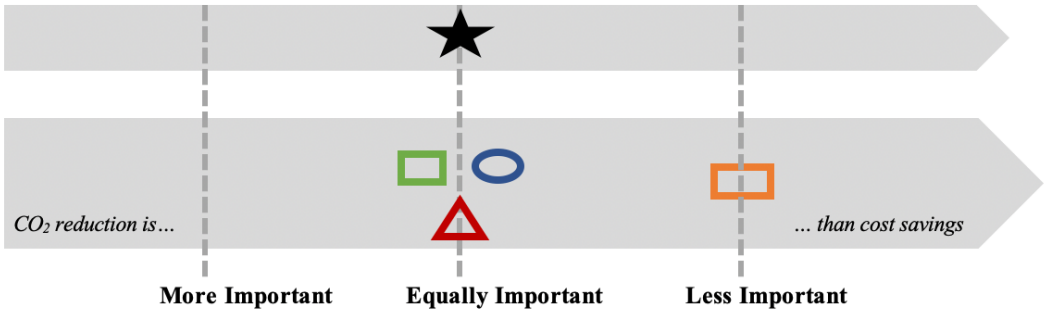
As opposed to Fraunhofer's view, it appears that the interviewees categorize their company's employee satisfaction as more important than or equally important to CO_2 reduction.

Customer Satisfaction



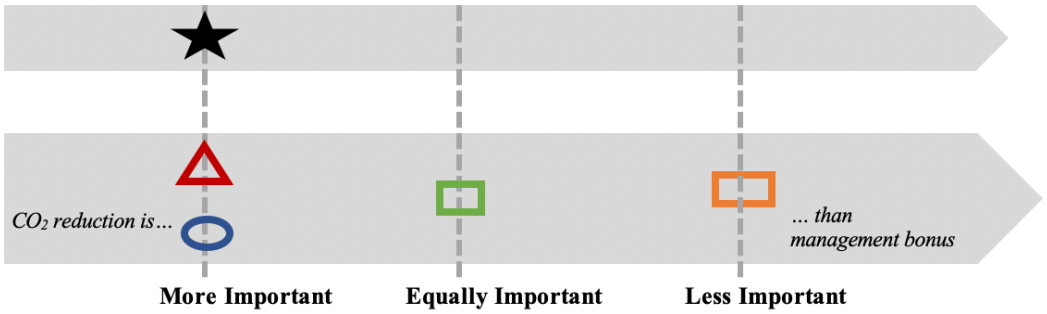
It appears that the interviewees categorize their company's customer satisfaction as more important than or equally important to CO_2 reduction. Fraunhofer's perspective is similar.

Cost Savings



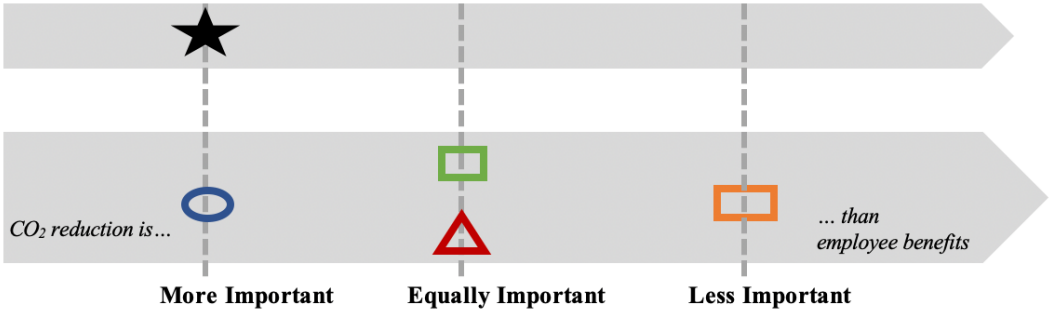
It appears that the interviewees categorize their company's cost savings as more important than or equally important to CO_2 reduction. Fraunhofer's perspective is similar.

Management Bonus



It appears that the interviewees have a dispersed view considering their company's management bonus.

Employee Benefits



It appears that the interviewees have a dispersed view considering their employee benefits.

Most effective strategies decreasing CO_2 output

Both of the German companies, BLG and ToF, have the opinion that the use of alternatively powered vehicles is an important strategy concerning the reduction of CO_2. This strategy leads to saving fossil fuels, thus the utilization of fuel with less CO_2 emissions.

BLG and both of the Portuguese organizations believe that the modernization of their truck fleet will lead to a lower fuel consumption followed by a decrease of the CO_2 output. BLG mentions that modern trucks have more efficient engines. LS is more specific towards this statement by saying that their refrigeration fleet can be renewed to reduce the CO_2 impact.

BLG states that the implementation of a telematic system and additional driver training gives feedback on the CO_2 output of the trucks. Furthermore, it gives the ability for optimization of the truck drivers driving style. ToF adds on to that by stating that the optimization of transport routes can lead to the increase of efficiency, reducing the CO_2 output by minimizing transport routes, thus fuel and energy consumption. PD argues that the capacity optimization in the operations leads to less empty truck usage.

LS did not state what strategies are the most important for the reduction of the CO_2 output. The company mentions that they want to reduce the vehicle fuel consumption and stimulate greater energy efficiency in warehouses. These measures enable the reduction of CO_2 and saving costs.

Fraunhofer sets focus on the increase of efficiency in the operations of the road transport companies. The research institute suggests the utilization of liquified natural gas trucks for long distance transports to decrease emissions. The utilization of freight exchange and digital platforms serves as a tool for the avoidance of empty running, optimizing the load factor of the vehicle. Lastly, the research institute suggests modal split between road and rail to improve and minimize the carbon footprint.

Future plans for CO_2 reduction

The participants were asked how they want to further decrease their carbon footprint in future operations. ToF and BLG both mention that they want to include renewable energy sources in their operations. BLG elaborates on that by stating that they intend on purchasing green electricity. In addition to that their own electricity production is in plan. Again, ToF and BLG want to increase the efficiency in their operations – more specifically the energy efficiency.

BLG plans to do so through the usage of alternative energy sources. ToF adds an idea for the reduction of CO_2: the increased use of reusable consumables.

Opinion on achieving the EGD

When asked about the European Green Deal, three of the companies - LS, BLG and ToF - are aware of it and the environmental targets that have been set for 2030. PD has not heard about the EGD.

Fraunhofer has an interesting point of view on the subject by stating that with the implementation of for example the diesel taxation alternative vehicles will be more cost-effective than conventional vehicles. Through the optimization of efficiency, the companies can accomplish a cost advantage and a competitive advantage. Fraunhofer argues that the industries need support from the legislation in form of the investment of infrastructure such as e.g. fast charging infrastructure for electric vehicles and overhead line technology.

ToF has the opinion, that the 90% reduction of GHG's by 2030 cannot be achieved unless there is an alternative to fossil fuels. Both, BLG and LS, believe that reaching the target could still be possible. The precondition for that are investments in infrastructure and operational processes by government and businesses.

Opinion on Social Commitment

When asked about the level of satisfaction concerning their company's social commitment, the respondents have indicated different answers.

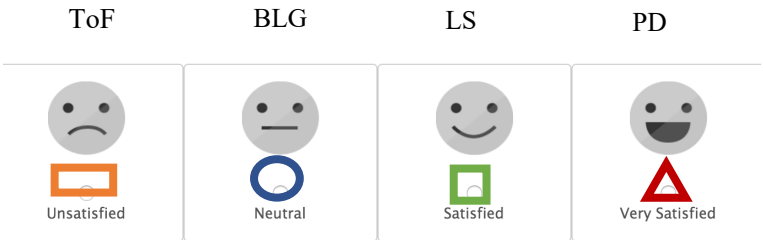


Figure 5.3. Rating of Company Social Commitment. Composed by author, 2020.

CHAPTER 6 – LIMITATIONS, CONCLUSION AND RECOMMENDATIONS

6.1 Limitations

This dissertation is focused on the insights and opinions by transport and logistics industry professionals, specifically four pre-selected companies – two from Germany and two from Portugal. To receive richer data from the German participants the author delivered the questionnaire in native language. Regarding the Portuguese sample, the questionnaire was delivered in English. With the process of translating the German interviews into the English language errors in interpretation could have occurred. The Portuguese participants could have had difficulties understanding the asked questions. This approach could have an effect on the derived findings.

A considerable limitation of this research was the narrow sample, hence the collection of the questionnaire data. Although different channels were used for reaching out to the interview participants it was difficult to receive replies. Reminders via email and telephone were beneficial and enabled the author to receive five questionnaire answers. The sample size of five participants, respectively two from each of the countries being observed, is large enough to represent and contrast perspectives and opinions. Although it needs to be said that it is too small to be representative and display generally occurring trends or opinions.

The data derived for the case studies was mainly based on the organizations published information – sustainability reports and data available on their website. This implies that the organization decides how they present themselves towards the public. That leads to data that cannot be categorized as objective.

As the EGD is an ongoing project in the EU, new resolutions are addressed regularly. This means that there are constant changes made. It implies, that the data collected in the literature review may not be up to date.

Further limitations include the time restrictions and the limit on the number of pages of the dissertation, given by the ISCTE Business School.

6.2 Conclusion

This dissertation aims to expand the knowledge concerning sustainability challenges in the road freight sector. The environmental pillar of sustainability has been in focus within this dissertation as the CO_2 impact of the sector is tremendous.

Contrasting the sustainability measures of Germany and Portugal, by means of four companies, brings insights into the topic. In addition to that, a German research institute was

questioned on its view on sustainable measures in the road transport sector. The insights of the industry professionals are utilized for the identification of differences and similarities in strategies/operations and challenges towards sustainable operations. The research questions that have been introduced in chapter one will be elaborated subsequently. The gathered literature and the research findings are the basis for the discussion.

RQ_1: Do Portugal and Germany have differences/similarities in their sustainability behavior and progress?

There are differences in sustainability challenges between the two countries, although they do not seem to be fundamental. On one hand, the data derived entails that the two Portuguese organizations truck fleets are slightly more modern based on the average Euro standard for PD and LS truck fleet. The mentioned companies show a fleet with an average of 95% categorized as Euro 5 and 6 standards, while the two German companies have a weighted average of around 85%.

On the other hand, it can be observed that the German organizations are significantly more transparent in their reporting when it comes to sustainability data - indicating that sustainability has a stronger penetration on the company's management and employee level.

A certification is a formal confirmation, that has been awarded in relation with an audit of the company's operations. The most common certifications among the organizations are the ISO 9001 and 14001. All of the organizations have been awarded with them. Both of the Portuguese companies have received the SQAS certification. The German companies have been awarded with the silver ranking by EcoVadis, whereas one of the Portuguese organizations has achieved a gold ranking.

When it comes to the social pillar of sustainability, the author could identify that the Portuguese as well as the German companies have similarities concerning the women's quota in their operational business. The average quote in all of the companies is at 25-30%, with one of the Portuguese companies leading with the women's quota.

The above observations are based on the small sample size of this study, the findings and conclusion cannot be seen as country representative.

RQ2: What are key challenges when it comes to sustainability in road freight transport?

It was found that the transport sector in the EU in 2017 was responsible for 27% of the total GHG emissions, with road transport responsible for 72% of the transport sector (European Environment Agency, n.d.). This displays the need for the transport sector to change operational processes to meet the national and international targets that have been agreed upon.

The challenges that could be identified with the help of the case studies and questionnaires, have been inserted in Figure 6. The challenge level of the implementation is specified by the x-axis, whereas the y-axis displays whether the challenge is of tactical or strategic nature. The author defines the challenges based on the complexity of regulation/policy making, investments for the delivery of public as well as private infrastructure, research and development processes.

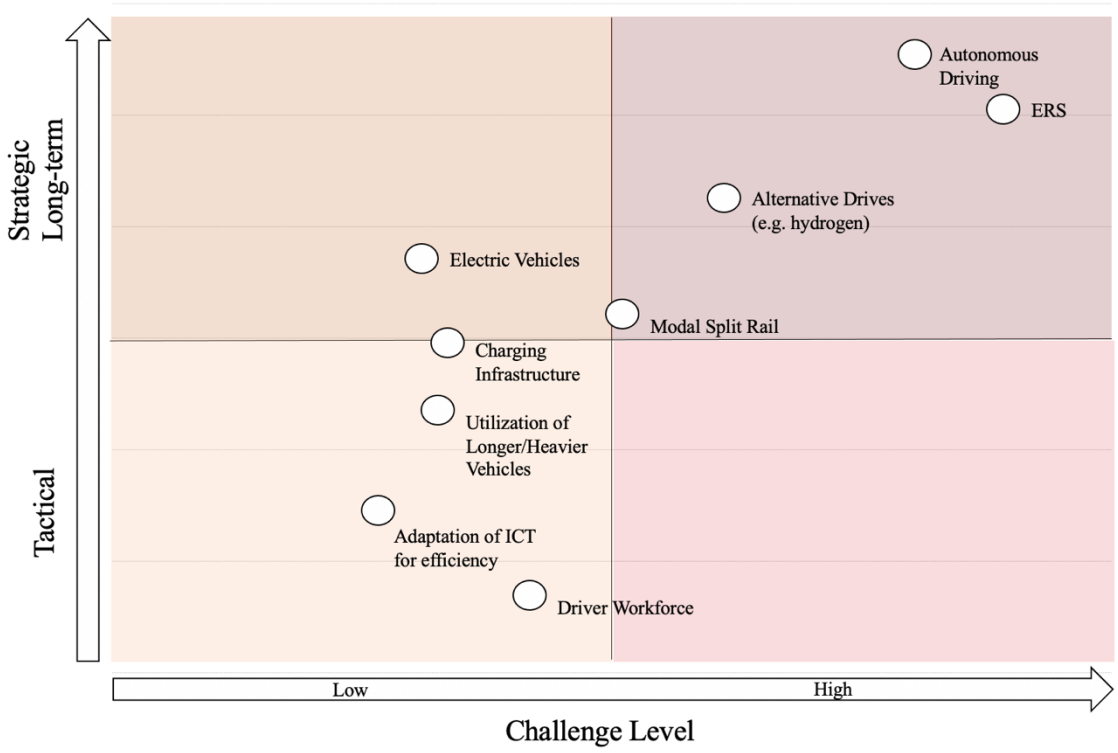


Figure 6.1. Matrix - Sustainability Challenges in Road Freight. Composed by author, 2020.

RQ_3: How can the sustainability performance in the road freight sector contribute to meet the targets set in the European Green Deal?

As the findings display the majority of the questionnaire participants knows about the EGD. The target that has been set, concerning all transportation modes, is the reduction of the GHG footprint by 90%, by 2050.

The precedent literature as well as Figure 6.1. highlights that the significant reduction of emissions has to be correlated with a change of the road and vehicle infrastructure and the reliance on fossil fuels. The electrification has begun concerning passenger vehicles and is increasing. When it comes to road freight vehicles it needs to be considered that the vehicles will need a much larger battery, which is related towards their weight and size. This implies the exploitation of the natural resource lithium, which is a limited resource and its extraction produces CO_2 emissions. In addition to that, it is of importance that a charging infrastructure needs to be in place to sustain such high numbers of electrified vehicles. At this point in time, the infrastructure is very limited.

Two of the companies that were analyzed displayed the use of gas trucks in their operations. ToF has started an experiment utilizing an electrified LCV for urban freight. The electrification of trucks carrying goods can be beneficial when it comes to short distance routes. With the current development of the technology, the batteries are not yet configured to drive long distances.

The ERS is another system that may help with the decrease of emission production. With the overhead technology the trucks would be able to charge their electric batteries while attached, ensuring efficient operations. The construction of the infrastructure would require high investments and its utilization would need to be guaranteed for decades. It should not be disregarded, that the trucks for these systems would need to be produced, which indicates the production of emissions.

The opinion, among the questionnaire participants, on reaching the 2050 target is somewhat skeptical. However, two of the road transport (LS, BLG) companies and the research organization (Fraunhofer) believe that the target could be met assuming significantly increased focus on incentives, financial support and resources from governments as well as a higher investment willingness from the corporate environment.

It is obvious that the road transport sector is increasingly aware of the environmental goals that need to be reached, and the necessity to contribute towards them. Furthermore, the author could identify concrete improvements regarding the company's truck fleet (efficiency and

utilization), operational processes and ICT support. The organizations have the ability to further increase their commitment to the decarbonization of the sector but are also relying on governmental support. With the findings derived and the conclusion above, it appears that the decarbonization of the road freight sector will take decades.

6.3 Recommendations

In order to gain a richer data set, future research could include further transport and logistics companies sharing their opinion on the reduction of CO_2 in their operations. This enables more representative data.

As the EGD concerns all of the member states, it would be beneficial to question the majority or all of them. This enables a better data concentration and can give a realistic outlook on the EU reaching the targets that have been set.

As the comparability of data among the companies, specifically the case studies utilized in this research, is not given, the standardization of reporting strategies would help with the comparability of the data provided. Furthermore, the comparison of the carbon output would be enabled. A quantitative study would be useful concerning the EU road transport companies carbon footprint.

From the authors perspective, the weights of the carbon reduction have been set on electrification. Although it seems like a promising measure for the reduction of emissions, it may not be beneficial towards the sector of road freight, especially for MFTs and HFTs. The focus concerning environmentally friendly operations should be expanded towards hydrogen and other alternatives.

With the emergence of COVID-19 the importance of sustainability has taken a back seat. It is believed that the increasing online demand of the society is related with the higher need for road freight operations, especially in the urban area. This is another reason for sustainable development. To stimulate the process regarding the adaptation of sustainable operations, managers should consider strategic roadmaps to stay on track of the development.

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Wehner, J. (2018). Energy Efficiency in Logistics: An Interactive Approach to Capacity Utilisation. Gothenburg, Sweden: Chalmers University of Technology.

CHAPTER 8 – APPENDICES

Appendix A: First Screening Scopus List

Scopus Key Word Search Readings

Literature Review - Scopus - 51 articles						
1st Screening Scopus Articles						
Number	**Article**	**Author**	**Year Published**	**Abstract Content**	**Category**	**Reason for Categorization**
1.	Transport and climate change: a review Journal of Transport Geography, 15 (5), pp. 354-367.	Chapman, L.	2007	This article discusses road freight in relation to its carbon footprint and behavioural change brought through policy.		Suitability of journal towards research
2.	The impact of logistics unvertainty on sustainable transport operations (2010) International Journal of Physical Distribution and Logistics Management, 40 (1-2), pp. 61-83. Cited 47 times	Sanchez-Rodrigues, V., Potter, A., Naim, M.M.	2010	Here the focus is set on main drivers impacting the sustainability of transport operations. It was fund that they are delays, variable demand/poor information, delivery constraints and		Suitability of journal towards research
3.	Assessing the impact of ICT on UK general haulage companies (2007) International Journal of Production Economics, 106 (1), pp. 12-27. Cited 41 times.	Ian Daviesa, Robert Masona,, Chandra Lalwanib	2007	This article elaborates on the road freight transport industry, using the UK as a case study.		On hands example EU (UK)
4.	The use of ICT in road freight transport for CO2 reduction - An exploratory study of UK's grocery retail industry (2015) International Journal of Logistics Management, 26 (1), pp. 2-29. Cited 26 times.	Wang, Y., Rodrigues, V.S., Evans, L.	2015	The researcherds found that information and communication technologies (ICT) can contribute to reduction of CO2 emissions in road freight transport and to identify opportunities for further		How ICT contributes CO2emissions reductions a
5.	Motorways of the sea policy in Europe (2013) Maritime Policy and Management, 40 (1), pp. 10-26. Cited 25 times.	Aperte, X.G. , Baird, A.J.	2013	This paper explores Motorways of the Sea (MoS) policy in Europe. The major objective of MoS policy is to shift freight from long-distance road transport		Focus on maritime and sea freight
6.	Intermodal versus unimodal road freight transport: A review of comparisons of the external costs (2006) Towards better Performing Transport Networks, pp. 17-42. Cited 20 times.	Kreutzberger, E. , Macharis, C. , Woxenius, J.	2006	This article sets focus on intermodal transport ,and the combination and integration of several modes. Both intermodal and unimodal transport have external effects. An overview is given of the types of external costs that were taken into		Relevant towards adjustment of operations of road freight sector, published almost 15 years ago
7.	Evaluating economic feasibility and technical progress of environmentally sustainable transport scenarios by a backcasting approach with ESCOT (2005) Transport Reviews, 25 (6), pp. 647-668. Cited 19 times.	Schade, B. , Schade, W.	2005	System Dynamics Model for Economic Assessment of Sustainability Policies of Transport (ESCOT) is to describe a path towards a sustainable transport system in Germany and to assess its economic impacts. ESCOT was developed within the environmentally sustainable transport (EST) project of the Organization for Economic Co-operation and Development (OECD) designed to set up the ecological and technical		Interesting to view the 2005 approach on transition towards sustainability, although practices may bes outdated
8.	Environmental sustainability in third-party logistics service providers: A systematic literature review from 2000-2016 (2018) Sustainability (Switzerland), 10 (5), art. no. 1627, . Cited 16 times.	Evangelista, P. , Santoro, L. , Thomas, A.	2018	Presenting the results of a systematic literature review of publications in the area of environmental sustainability in third- party logistics service providers (3PLs) between the years 2000 and 2016.		Sustainability challenges and solutions may unravel
9.	The longer and heavier vehicle debate: A review of empirical evidence from Germany (2015) Transportation Research Part D: Transport and Environment, 40, pp. 114-131. Cited 16 times.	Sanchez Rodrigues, V. , Piecyk, M. , Mason, R. , Boenders	2015	Adoption of Longer Heavier Vehicles (LHVs) from the perspective of logistics service providers (LSPs). The research consists of six case studies and a survey of companies which were involved LHV trials in Germany.		Published 5 years ago, empirical evidence from Germany
10.	Comparison of road freight transport trends in Europe. Coupling and decoupling factors from an Input-Output structural decomposition analysis (2015) Transportation Research Part A: Policy and Practice, 82, pp. 141-157. Cited 15 times.	Alises, A., Vassallo, J.M.	2015	Decoupling road freight transport from economic growth has been acknowledged by the European Union as a key means to improving sustainability.		Road transport demand has grown-driven mainly by economic activity-, data set from 2000 to 2007

11.	Analysis of greenhouse gas emissions in the road freight transportation using simulation (2018) Journal of Cleaner Production, 170, pp. 298-309. Cited 11 times.	Marcilio, G.P., Rangel, J.J.D.A., Souza, C.L.M.D., Shimoda, E., Silva, F.F.D., Peixoto, T.A.	2018	Analyzes the behavior of environmental and performance variables in the Lean Manufacturing versus Green Manufacturing context in a road freight transportation system . Results display, that the behavior of the transport structures cannot be generalized, as different scenarios had different results on the performance of the Supply Chain when analyzing factors such as Types of delivery fleet, Age of the fleet and Driving style.		Has inspected variables relevant for the sustainable development in manufacturing of a road freight transportation system
12.	A novel approach for assessing sustainable city logistics (2017) Transportation Research Procedia, 25, pp. 1036-1045. Cited 10 times.	Nathanail, E., Adamos, G., Gogas, M.	2017	Urban road freight transport significantly affects the quality of life in the urban environment. Optimization of urban freight transport (UFT) can make an important contribution to the sustainability and livability of cities, conducing in the alleviation of traffic congestion and the mitigation of CO2 emissions and noise impacts.		Urban road freight and the CO2 reduction within are relevant towards the overall CO2 reduction
13.	Peculiarities of illegal immigrant's intrusions into road freight transport units in the France - UK corridor (2018) Entrepreneurship and Sustainability Issues, 5 (3), pp. 634-647. Cited 9 times.	Lietuvnikė, M.M. , Vasilis Vasiliauskas, A. , Vasilienė-Vasiliauskienė, V. , Sabaitytė, J.	2018	Article presents results of the study aimed at investigation of peculiarities of illegal immigrant's intrusions into road freight transport units moving along the corridor France.		Article contents not suitable towards research
14.	Macro-logistics and externality cost trends in South Africa – underscoring the sustainability imperative (2015) International Journal of Logistics Research and Applications, 18 (2), pp. 118-139. Cited 9 times.	Havenga, J.H.	2015	The logistics industry in a fossil fuel-challenged global economy are highlighted by transportation's rising contribution to logistics costs, as evidenced in the USA's and South Africa's logistics costs time series, the two longest-running such series available globally. The anticipated persistence of rising, volatile oil prices and mounting pressure to account for externalities will exacerbate the increase in transport costs (TCs).		Article contents not suitable towards research, South African development not comarable to European
15.	Scenarios for the Brazilian road freight transport industry (2012) Foresight, 14 (3), pp. 207-224. Cited 9 times.	Martins, P.P.P. , Boaventura, J.M.G. , Fischmann, A.A. , Costa, B.K. , Spers, R.G.	2012	Developing scenarios for the road freight transport industry in Brazil and evaluating the effectiveness.		Scenarios developed for the Brazilian market (again not comparable with EU). No relation towards sustainability challenges.
16.	Green initiatives for logistics service providers: An investigation of antecedent factors and the contributions to corporate goals (2018) Journal of Cleaner Production, 191, pp. 1-14. Cited 8 times.	Sureeyatanapas, P. , Poophiukhok, P. , Pathumnakul, S	2018	Insights into the initiation of green policies within logistics companies by investigating the significant factors that influence the adoption of green practices, along with the ranking orders of several green activities in terms of their contributions to two corporate goals: cost reduction and environmental protection.		Logistic Service Providers form Thailand, relevant correlations in terms of implementation of green logistics
17.	Policy oriented emission factors for road freight transport (2017) Transportation Research Part D: Transport and Environment, 61, pp. 33-41. Cited 8 times.	Dente, S.M.R. , Tavasszy, L.	2017	Impact assessments of carbon emission mitigation policies by shippers and carriers require appropriate emission models and indicators of logistics activity. develop a policy oriented framework of simplified emission factors that are derived from 2 models. coTransIT World Model and the Ligterink model.		Is another framework required? (t/km used in various sources)

18.	The Roads' Role in the Freight Transport System (2016) Transportation Research Procedia, 14, pp. 1443-1452. Cited 8 times.	Engström, R.	2016	Roads constitute a fundamental part of this system for both passenger and freight transports. Freight transport is expected to increase throughout Europe by 80% until 2050 (EU, 2011).This paper describes the role of the road in the freight transport system. mportant road freight areas and issues about how to reach a more sustainable freight system are identified and discussed in this paper.		EU point of view on the role of the road freight system and ist transformation towards sustainability
19.	Energy efficiency in logistics: An interactive approach to capacity utilisation (2018) Sustainability (Switzerland), 10 (6), art. no. 1727, . Cited 7 times.	Wehner, J.	2018	This paper takes an interactive approach to capacity utilisation, to contribute to sustainable freight transport and logistics, by identifying its causes and mitigations.		Displays causes of unutilzed capaciyt in relation to their mitigations, and the need for a standardized approach to measure environmental impact
20.	Combining Facility Location and Routing Decisions in Sustainable Urban Freight Distribution under Horizontal Collaboration: How Can Shippers Be Benefited? (2017) Mathematical Problems in Engineering, 2017, art. no. 8687515, . Cited 7 times.	Ouhader, H., El kyal, M.	2017	This article investigates the potential economic, environmental, and social effects of combining depot location and vehicle routing decisions in urban road freight transportation under horizontal collaboration. cenarios show that collaboration leads to a reduction in CO2 emissions, transportation cost, used vehicles, and travelled distances in addition to the improvement of the vehicles load rate but collaboration affects negatively social impact.		Relevant concerning urban road freight emission reduction
21.	Carbon emissions growth and road freight: Analysis of the influencing factors in Tunisia (2015) Transport Policy, 42, pp. 121-129. Cited 6 times.	M'raihi, R. , Mraihi, T. , Harizi, R.,Taoufik Bouzidi, M , Taoufik Bouzidi, M.	2015	Analysis of the the effects of main driving factors of total CO2 emissions in Tunisia during the period 1990-2006. results have shown that economic growth is the principal factor driving the CO2emission growth. Changes in average emission of fossil fuels is the primarily factor driving the CO2emission changes.		Findings display findings similar to the ones in EU. Tunisia cannot be compared to EU standards.
22.	Towards sustainable wood procurement in forest industry – The energy efficiency of larger and heavier vehicles in Finland (2018) Renewable and Sustainable Energy Reviews, 96, pp. 100-118. Cited 5 times.	Palander, T. , Haavikko, H. , Kärhä, K.	2018	The purpose of this paper is to discuss how the local biofuel cycling through larger and heavier vehicles may affect the sustainability of wood procurement in the industrial ecosystem by focusing on transport efficiency, cost-efficiency and energy efficiency.		Strong focus on the wood procurement in forest industry
23.	Sustainability intervention mechanisms for managing road freight transport externalities: A systematic literature review (2018) Sustainability (Switzerland), 10 (6), art. no. 1923, . Cited 5 times.	Tob-Ogu, A. , Kumar, N. , Cullen, J., Ballantyne, E.E.F.	2018	Examination the academic literature on road freight transport sustainability between 2001 and 2018.		Insights into other findings concerning sustainability in road freight
24.	A security plan procedure for Heavy Goods Vehicles parking areas: An application to the Lazio Region (Italy) (2014) Transportation Research Part E: Logistics and Transportation Review, 65 (1), pp. 35-49. Cited 5 times.	Carrese, S., Mantovani, S., Nigro, M.	2014	The design, construction and operation of Heavy Good Vehicles (HGVs) parking areas are yet not well defined. The result is that the number of existing and planned infrastructures is far from being capable of satisfying the driver demand for secure and comfortable parking spaces.		Focus on a specific region in Italy, very specific towards Heavy Duty Vehicle parking areas and their improvement
25.	Environmental management in the transport sector: Findings of a quantitative survey (2012) EuroMed Journal of Business, 7 (3), pp. 268-279. Cited 5 times.	Oberhofer, P., Fürst, E.	2012	This paper is to examine the status quo of environmental management in the Austrian road freight transport sector.		Perspectiv from EU member Austria
26.	Electric road systems: Strategic stepping stone on the way towards sustainable freight transport? (2018) Sustainability (Switzerland), 10 (4), art. no. 1148, . Cited 4 times.	Schulte, J., Ny, H.	2018	This study looks at Electric Road Systems (ERS) in comparison to the current diesel system.		Electrification in form of Electric Road Systems can be relevant towards sustainable development

27.	Improving the sustainability of road freight transport by relaxing truck size and weight restrictions (2011) Supply Chain Innovation for Competing in Highly Dynamic Markets: Challenges and Solutions, pp. 185-198. Cited 4 times.	McKinnon, A.	2011	Reviews recent studies onlegalise longer and heavier vehicles presenting an analytical framework and focuses on three critical issues: the extent to which loads can be consolidated in LHVs, their effect on the freight modal split and the possibility that the resulting reduction in road freight costs will stimulate additional traffic growth.		Impact of longer and heavier vehicles to minimize carbon footprint
28.	Risk evaluation and mitigation of sustainable road freight transport operation: a case of trucking industry (2019) nternational Journal of Production Research, 57 (19), pp. 6223-6245. Cited 3 times.	Kumar Dadsena, K. , Sarmah, S.P. , Naikan, V.N.A.	2019	The transport managers across the globe are finding it difficult to manage the increasing risks in its operation and implementation of risk-mitigation strategies. However, very few literatures have examined the impact of sustainable risk management practices on road freight transportation. Our study addresses this important gap in the literature.		Focus on sustainable risk managemenmt, directed at managers directly
29.	Assessing the impacts of road freight transport on sustainability: A case study in the sugar-energy sector (2019) Journal of Cleaner Production, 220, pp. 995-1004. Cited 2 times.	De Campos, R.S., Simon, A.T., De Campos Martins, F.	2019	The objective of this paper is to propose a method for assessing the impacts of road freight transport on all three dimensions of sustainability (social,environmental,economic).		Method for social, environmental and economic sustainability can be beneficial towards the researchs outcome
30.	Trust and distress prediction in modal shift potential of long-distance road freight in containers: Modeling approach in transport services for sustainability (2018) Sustainability (Switzerland), 10 (7), art. no. 2370, . Cited 2 times.	Szaruga, E. , Skapska, E. , Załoga, E. , Matwiejczuk, W.	2018	The objective of this article is to indicate the directions and criteria for that indicate the implementation of the paradigm shift, relative to the idea of sustainable transport.		Focus on trust and distress status concerning shift to sustainability
31.	Road freight transport to, from, and within London (2014) London Journal, 39 (1), pp. 59-75.	Allen, J. , Browne, M.	2014	Development of road freight transport operations to, from, and within London, from medieval times to the present.		Display of road freight in London without focus on sustainability
32.	Improving the sustainability of road freight transport by relaxing truck size and weight restrictions Sustainable Practices: Concepts, Methodologies, Tools, and Applications, 3, pp. 1265-1278.	McKinnon, A.	2013			
33.	A sustainable transport competitiveness analysis of the China Railway Express in the context of the belt and road initiative Sustainability (Switzerland), 11 (10), art. no. 2896, .	Li,S. ,Lang,M. ,Yu,X. ,Zhang,M. ,Jiang,M. ,Tsai,S. ,Wang,C.-K. ,Bian,F.	2019	The paper constructs a multi-logit model based on generalized cost functions, including economics, timeliness, reliability, convenience, safety, and environmental protection.		Focus on China Railway Express, and freight from Asia to Europe
34.	Eco-friendly 3D-Routing: A GIS based 3D-Routing-Model to estimate and reduce CO2-emissions of distribution transports Computers, Environment and Urban Systems, 73, pp. 40-55.	Schröder, M., Cabral, P.	2019	Introduces a Geographic Information System (GIS) based 3D-Routing-Model, which incorporates models to estimate vehicle fuel consumption. co-friendly routes can yield significant fuel and emission saving potentials of up to 20% in the tested scenarios. However, eco-friendly routes are characterized by longer distances as well as operation times, which leads to increased expenses.		Route optimization to minimize CO2
35.	Assessment of the political city logistics initiatives sustainability (2018) Transportation Research Procedia, 30, pp. 285-294.	Tadić, S., Zečević, S., Krstić, M.	2018	Analyze the sustainability of political City Logistics initiatives and their ranking in relation to the goals and requirements of different stakeholders, as well as to develop and implement a methodology for solving this problem.		Very specific viewing political city logistics initiatives
36.	A social marketing perspective on road freight transportation of fresh fruits and vegetables: A Slovene case amEconomic Research-Ekonomska Istrazivanja, 30 (1), pp. 1132-1151. Cited 1 time.	Bonča, S. , Udovč, A. , Rodela, R.	2017	This analysis focuses on road freight transport of selected produce (carrots, cabbage, apples and pears) with the aim to appraise the sustainability of road freight transport of these for the Slovene market.		Country specific categorization of transport sustainability for different products

37.	Estimating the carbon footprint of a road freight firm, perspectives to mitigate these emissions International Journal of Business Performance and Supply Chain Modelling, 6 (3-4), pp. 239-254.	Jaegler, A. , Gondran, N	2014	This paper proposes a study at a micro-economic scale of the estimation of the carbon footprint of a road freight company in 2009. The main objectives are twofold: identifying the main emissions sources and finding the best solutions for a greener supply chain.		Focus on mitigation strategies for road freight
38.	City logistics: Are sustainability policies really sustainable? Direccion y Organizacion, 53, pp. 45-50.	Grosso, R., Muñuzuri, J., Cortes, P., Carrillo, J.	2014	This paper aims to evaluate one of these policies in a quantitative way to answer the question 'are the sustainable policies really sustainable?'		Strong focus on answering the question: are sustainability policies really sustainable?
39.	The line haul cost and cost drivers for road freight transportation in China IEEM 2009 - IEEE International Conference on Industrial Engineering and Engineering Management, art. no. 5373135, pp. 1679-1683.	Wang, L.	2009	In recent years, many companies of road freight transportation in China have suffered from performance decline and business distress because of the continual rise of the costs and the long-term downturn of the freight rate. The line haul cost model with light-duty truck for a round trip is developed, and sensitivity analysis and tornado graphs are conducted to estimate the line haul cost and to identify the cost drivers in this study.		Research designed for China and its circumstances specifically
40.	Using system dynamics to analyze the development of urban freight transportation system based on rail transit: A case study of Beijing Sustainable Cities and Society, 53, art. no. 101923,	Hu, W. ,Dong,J. ,Hwang,B.-G. ,Ren,R. ,Chen,Y. ,Chen,Z	2020	Integrating logistics activities into urban passenger rail transit network (URFT) is regarded as an effective approach to promote urban sustainability and reduce the negative externalities of road-based transportation. This study applied a system dynamics method to simulate URFT system development by focusing on internal operations and external impacts.		Focus on urban passenger rail transit network, thus not road freight
41.	Evaluating impacts of overweight in road freight transportation: A case study in Brazil with system dynamics Sustainability (Switzerland), 11 (11), art. no. 3128, .	Ghisolfi, V. , Ribeiro, G.M. , Chaves, G.L.D. , Filho, R.D.O. , Hoffmann, I.C.S. , Perim, L.R.	2019	This paper evaluates the relationship between different policies for the loading of ornamental stone vehicles and its externalities, such as the impact on costs with transportation, pavement maintenance and road accidents, using the System Dynamics (SD) method.		Not sufficient information concerning the subject matter
42.	Decarbonizing freight transportation: An integrated EFA-TISM approach to model enablers of dedicated freight corridors Technological Forecasting and Social Change, 143, pp. 85-100.	Shankar, R. , Pathak, D.K. , Choudhary, D.	2019	Technology-enabled energy efficient freight transportation have led to the development of dedicated freight corridors (DFCs) in many countries like Germany, Netherlands, Austria, and India. The rapid expansion of DFCs is needed to improve supply chain efficiency.		DFC's and advanced technologies to reach decarbonization
43.	On-road freight complexities Nature Sustainability, 2 (2), p. 77		2019	Transforming human systems to achieve sustainability.		Not sufficient information
44.	Survey on the relation between road freight transport, SCM and sustainable development Yugoslav Journal of Operations Research, 29 (2), pp. 151-176.	Ech-Chelfi, W., Elhammoumi, M.	2019	Categorize research related to Supply Chain Management (SCM), road freight transport, and sustainable development and to classify treated papers in chronological order.		Road freight transport and supply chain management in the context of sustainable development
45.	A multistakeholders multicriteria decision support platform for assessing urban freight transport measures Lecture Notes in Networks and Systems, 36, pp. 17-31.	Nathanail, E.	2018	This research aims at deepening the knowledge and understanding of urban freight transportation, and giving guidance concwerning the selection and implementation of effective and sustainable policies and measures in a city.		Concerns urban freight and implementation of sustainable policies
46.	The emission of polluting gases in Brazilian road freight transport [A emissão de gases poluentes no transporte rodoviário de cargas brasileiro] Espacios, 39 (48), 12 p.	Soliani, R.D. , Argoud, A.R.T.T	2018	Te purpose of this article is to understand how sustainability concepts can be applied to influence the reduction of greenhouse gas emissions.		Brazilian data may not be comparable to Europe

47.	Green logistics: Developments in vehicle routing models OR58: The OR Society Annual Conference, pp. 172-182.	Eglese, R.W.	2016	Different types of models for estimating fuel consumption and emissions are introduced, particularly describing the differences between average speed and instantaneous models. Then vehicle routing models for road freight transport will be discussed. ehicle routing models for alternatively powered vehicles, including electric vehicles, are discussed.		Vehicle routing models can contribute towards reseaerch
48.	A methodology for estimating greenhouse gas emissions in construction road transportation Proceedings, Annual Conference - Canadian Society for Civil Engineering, 1, pp. 557-568.	Amin, M., Sadeghpour, F.	2015	The objective of this study is to develop a methodology to estimate emissions from a single HDDV (Heavy Duty Diesel Vehicle) used in the construction sector.		Very narrow research area: Heavy Duty Diesel vehicle
49.	The impact of route planning on Greenhouse Gas emissions in construction transportation Proceedings, Annual Conference - Canadian Society for Civil Engineering, 2 (January), pp. 1109-1118.	Amiri, M., Sadeghpour, F., Tahmasseby, S.	2013	The objective of this study is to propose a method to investigate the impact of the route choice, as a behavioural change, on the GHG emissions resulted from construction road transportation.		Focus on construction road freight, another view on the choice of route would be interesting to view
50.	Evaluating vehicle routing problems with sustainability costs ICORES 2012 - Proceedings of the 1st International Conference on Operations Research and Enterprise Systems, pp. 175-180.	Eguia, I., Racero, J., Guerrero, F.	2012	A mathematical model is described and an illustrative example is performed.		Very mathematical and in depth
51.	Freight traffic: Managing the Fundamental Drivers of Transport Demand, , pp. 15-25.	Vickerman, R., Monnet, J.	2003	In Europe much faster growth in freight traffic, and particularly in road freight traffic, than in output.		Published in 2003, may have interesting insights concerning freight traffic in Europe

Legend:	
Contributes towards research	23
Other subject area/not suitable	27
Invalid	1

Green Categorization moves on to 2nd Screening

Criteria for selection of articles:
Date of publishing
Comprehensibility
Suitability to research/topic
Comparability to Europe

Appendix B: Identified Themes and Second Screening Scopus List

Identified Themes :				
Road Freight Operations	Fuel Efficiency	Vehicle Utilization	Vehicle Optimization	Process Optimization
Road Freight Infrastructure	Dedicated Freight Corridors	City/Urban Logistics	Electric Road Systems	Road Infrastructure
ICT	Route Optimization	Efficiency		
Administrative Policies	Decoupling Economic Activity from Road Freight	European Grean Deal	Regulations	
Other Strategies	Modality	Electrification	Lower Carbon Fuel/ Biofuel	Road Freights Impact on Sustainability

Not utilized for Literature Review
Removed From Screening

2nd Screening - Scopus Articles

Number	Article	Author	Year Published	Description	Identified Theme	Reason for Categorization
1.	Transport and climate change: a review Journal of Transport Geography, 15 (5), pp. 354-367.	Chapman, L.	2007	Discovers the relationship of policies and regulations in relation to the decrease of the carbon footprint produced by the road freight sector	**Administrative and Governmental Policies** Regulations	Suitability of journal towards research
2.	The impact of logistics unvertainty on sustainable transport operations (2010) International Journal of Physical Distribution and Logistics Management, 40 (1-2), pp. 61-83. Cited 47 times	Sanchez-Rodrigues, V., Potter, A., Naim, M.M.	2010	McKinnon's Framework linking supply mitigation of supply chain uncertainty within transport operations can minimise the risk of disruptions in the delivery process, so transport resources can be utilised in the most efficient and less polluted manne chain processes with CO2 emissions	**Road Freight Operations** How uncertainty in logistics impacts sustainable operations	Suitability of journal towards research
3.	Assessing the impact of ICT on UK general haulage companies (2007) International Journal of Production Economics, 106 (1), pp. 12-27. Cited 41 times.	Ian Daviesa, Robert Masona,, Chandra Lalwanib	2007	The impact of information and communication technology (ICT) on the haulage operations of the road freight sector in the UK.	**ICT** Efficiency - Usage of ICT for CO2 reduction UK	On hands example EU (UK)
4.	The use of ICT in road freight transport for CO2 reduction - An exploratory study of UK's grocery retail industry (2015) International Journal of Logistics Management, 26 (1), pp. 2-29. Cited 26 times.	Wang, Y., Rodrigues, V.S., Evans, L.	2015	The authors studied the utilization of ICT on four levels : 1. vehicle and load, 2. company, 3. supply chain and 4. network.	**ICT** Efficiency - Usage of ICT for CO2 reduction UK	How ICT contributes CO2 emissions reductions, European country
5.	Environmental sustainability in third-party logistics service providers: A systematic literature review from 2000-2016 (2018) Sustainability (Switzerland), 10 (5), art. no. 1627, . Cited 16 times.	Evangelista, P. , Santoro, L. , Thomas, A.	2018			Sustainability challenges and solutions may unravel
6.	The longer and heavier vehicle debate: A review of empirical evidence from Germany (2015) Transportation Research Part D: Transport and Environment, 40, pp. 114-131. Cited 16 times.	Sanchez Rodrigues, V. , Piecyk, M. , Mason, R. , Boenders	2015	The need for longer and heavier vehicles in Europe has been rising. The logistics sector in Germany sees environmental, economic and social benefits in the adoption of those vehicles.	**Road Freight Operations** Vehicle Optimization	Published 5 years ago, Empirical evidence from Germany
7.	Comparison of road freight transport trends in Europe. Coupling and decoupling factors from an Input-Output structural decomposition analysis (2015) Transportation Research Part A: Policy and Practice, 82, pp. 141-157. Cited 15 times.	Alises, A., Vassallo, J.M.	2015	3 positive outcomes of decoupling road freight and economic activity: 1. The transformation towards a service directed industry can reduce the demand in goods, thus transportation. 2. Logistics and manufacturing processes can be optimized through the implementation of information and communication technology (ICT). 3. The need of the supply chain system to transform its entire operations towards efficiency.	**Administrative and Governmental Policies** Decoupling	Road transport demand has grown-driven mainly by economic activity-, data set from 2000 to 2007

8.	Analysis of greenhouse gas emissions in the road freight transportation using simulation (2018) Journal of Cleaner Production, 170, pp. 298-309. Cited 11 times.	Marcilio, G.P., Rangel, J.J.D.A., Souza, C.L.M.D., Shimoda, E., Silva, F.F.D., Peixoto, T.A.	2018			Inspected variables relevant for the sustainable development in manufacturing of a road freight transportation system
9.	A novel approach for assessing sustainable city logistics (2017) Transportation Research Procedia, 25, pp. 1036-1045. Cited 10 times.	Nathanail, E., Adamos, G., Gogas, M.	2017	Optimization of urban road freight operations can reduce the carbon footprint, thus increasing the well-being of the reseidents.	**Freight Infrastructure** Urban Logistics	Urban road freight and the CO2 reduction within are relevant towards the overall CO2 reduction
10.	The Roads' Role in the Freight Transport System (2016) Transportation Research Procedia, 14, pp. 1443-1452. Cited 8 times.	Engström, R.	2016	The importance of an efficient road infrastructure towards the operations of the road freight sector.	**Freight Infrastructure** Road Infrastructure	EU point of view on the role of the road freight system and ist transformation towards sustainability
11.	Energy efficiency in logistics: An interactive approach to capacity utilisation (2018) Sustainability (Switzerland), 10 (6), art. no. 1727, . Cited 7 times.	Wehner, J.	2018	The interviews conducted lead to results laying out a framework consisting of three pillars tackling the issue of unutilized capacity.	**Freight Operations** Capacity Utilization	Displays causes of unutilzed capaciyt in relation to their mitigations, and the need for a standardized approach to measure environmental
12.	Combining Facility Location and Routing Decisions in Sustainable Urban Freight Distribution under Horizontal Collaboration: How Can Shippers Be Benefited? (2017) Mathematical Problems in Engineering, 2017, art. no. 8687515, . Cited 7 times.	Ouhader, H., El kyal, M.	2017	Collaboration on the horizontal axis decreases emissions and transport costs. Additionally less vehicles are utilized, decreasing congestion.	**Road Freight Infrastructure** Urban Freight	Relevant concerning urban road freight emission reduction
13.	Sustainability intervention mechanisms for managing road freight transport externalities: A systematic literature review (2018) Sustainability (Switzerland), 10 (6), art. no. 1923, . Cited 5 times.	Tob-Ogu, A. , Kumar, N. , Cullen, J., Ballantyne, E.E.F.	2018			Insights into other findings concerning sustainability in road freight
14.	Environmental management in the transport sector: Findings of a quantitative survey (2012) EuroMed Journal of Business, 7 (3), pp. 268-279. Cited 5 times.	Oberhofer, P., Fürst, E.	2012	The implementation of environmenral management practices can lead to a competitive advantage in the market as consumers start seeing green initiatives as more favorable – ideally leading to customer loyalty. Furthermore, there is a positive effect on the brand image of the organization.	**Other Strategies** Road Freights Impact on Sustainability	Perspectiv from EU member Austria
15.	Electric road systems: Strategic stepping stone on the way towards sustainable freight transport? (2018) Sustainability (Switzerland), 10 (4), art. no. 1148, . Cited 4 times.	Schulte, J., Ny, H.	2018	Electric Road Systems are depending on the production of energy, to imrove/reduce the carbon footprint it needs to be renewable. Furthermore, high investment for the infrastructure would be necessary.	**Road Freight Infrastructure** Electric Road Systems	Electrification in form of Electric Road Systems can be relevant towards sustainable development
16	Improving the sustainability of road freight transport by relaxing truck size and weight restrictions (2011) Supply Chain Innovation for Competing in Highly Dynamic Markets: Challenges and Solutions, pp. 185-198. Cited 4 times.	McKinnon, A.	2011			Impact of longer and heavier vehicles to minimize carbon footprint
17	Assessing the impacts of road freight transport on sustainability: A case study in the sugar-energy sector (2019) Journal of Cleaner Production, 220, pp. 995-1004. Cited 2 times.	De Campos, R.S., Simon, A.T., De Campos Martins, F.	2019			Method for social, environmental and economic sustainability can be beneficial towards the researchs outcome
18.	Eco-friendly 3D-Routing: A GIS based 3D-Routing-Model to estimate and reduce CO2-emissions of distribution transports Computers, Environment and Urban Systems, 73, pp. 40-55.	Schröder, M., Cabral, P.	2019	3D route modellling can be beneficial towards the optimization of routes decreasing the transports carbon emissions as well as their fuel consumption by about 20% (if environmentally freindly route is chosen). The authors question the sector's investment in sustainable development as the economic benefit is not clear.	**ICT** Route Optimization to minimize CO2	Technology utilization for the analysis of environmetally friendlier routes

19.	Estimating the carbon footprint of a road freight firm, perspectives to mitigate these emissions International Journal of Business Performance and Supply Chain Modelling, 6 (3-4), pp. 239-254.	Jaegler, A. , Gondran, N	2014			Focus on mitigation strategies for road freight
20.	Decarbonizing freight transportation: An integrated EFA-TISM approach to model enablers of dedicated freight corridors Technological Forecasting and Social Change, 143, pp. 85-100.	Shankar, R. , Pathak, D.K. , Choudhary, D.	2019			DFC's and advanced technologies to reach decarbonization
21.	Survey on the relation between road freight transport, SCM and sustainable development Yugoslav Journal of Operations Research, 29 (2), pp. 151-176.	Ech-Chelfi, W., Elhammoumi, M.	2019			Road freight transport and supply chain management in the context of sustainable development
22.	A multistakeholders multicriteria decision support platform for assessing urban freight transport measures Lecture Notes in Networks and Systems, 36, pp. 17-31	Nathanail, E.	2018			Concerns urban freight and implementation of sustainable policies
23.	Green logistics: Developments in vehicle routing models OR58: The OR Society Annual Conference, pp. 172-182.	Eglese, R.W.	2016	<		Vehicle routing models can contribute towards reseaerch

Appendix C: Global Vehicle Stock

In millions (LVC, MFT, HFT)

Geographic Region	Light Commercial Vehicle (LCV)	Medium Freight Truck (MFT)	Heavy Freight Truck (HFT)	TOTAL
North America	22,9	5,6	3,1	**31,6**
Europe	26,0	1,7	3,3	**31**
Russia	2,7	0,9	0,9	**4,5**
China	17,7	3,5	6,2	**27,4**
Japan	11,0	1,4	0,6	**13**
Australia& New Zealand	2,9	0,3	0,2	**3,4**
India	4,4	2,2	1,6	**8,2**
Middle East	6,7	2,2	1,3	**10,2**
Africa	9,2	4,7	2,0	**15,9**
Latin & South America	14,6	3,2	2,4	**20,2**
TOTAL	**118,1**	**25,7**	**15,6**	**159,4**

Adapted from: The future of trucks Implications for energy & the environment, International Energy Agency 2018.

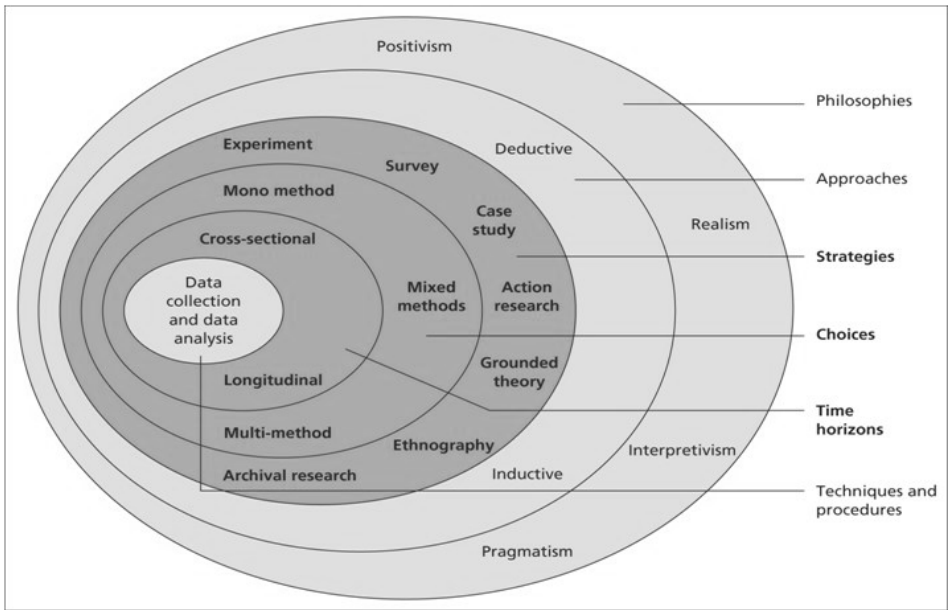
Appendix D: Amount of Goods Transported, by Mode of Transport

In 10^3 tons

Mode of Transport	2012	2013	2014	2015	2016
Rail	9,701	9,291	10,304	11,122	10,420
Road	158,958	161,689	157,903	154,832	148,626
Sea	62,111	72,173	74,904	81,413	83,937
Air	185	187	196	193	199

Adapted from: Estatísticas dos Transportes e Comunicações 2016, Instituto Nacional de Estatística 2018.

Appendix E: Research Onion



Reprinted from: Research methods for business students, by Saunders, Mark; Lewis, Philip; Thornhill, Adrian, 2009.

Appendix F: Thematic Categories Case Studies

Based on 3 Spheres of Sustainability

Economic	Environmental	Social
• Code of Conduct/Business Ethics	• Emissions • Energy • Vehicles • Buildings • Driving Behavior • Certifications • Customer Offer • Employee Awareness	• Diversity/Equal Opportunities • Safety and Health • Worker Satisfaction • Social Commitment • Training and Education

Categories reprinted from: BLG (2019), trans-o-flex (2018), Luís Simões (2019), Paulo Duarte (n.d.).

Appendix G: Questionnaire Master – PT/GE road freight companies

Template of the distributed questionnaire

Introduction

My name is Alina Mago and the purpose of this questionnaire is to identify challenges of sustainability in the road freight sector, with a focus on the environmental challenges.
The study is conducted with the ISCTE Business School in Portugal, Lisbon, and serves the development of my Master Thesis. The aim of the research is the comparison of Portuguese and German transport practices.

Your participation is voluntary. Your response is based on personal beliefs and will only be utilized for this research. The information obtained will be handled anonymously, and according to the rules of the General Data Protection. It will take approximately 15 minutes to complete the compiled questions.

Thank you for your cooperation!

Definition Sustainability

Sustainability signifies 'meeting the needs of the present without compromising the ability of future generations to meet their own needs' (International Institute for Sustainable Development , n.d.). It is based on the three pillars: economic, environmental, and social.

Challenges of Sustainability in the Road Freight Sector – Questions

1. What is your current job position in the organization?
   a) Senior Management
   b) Management
   c) Operations
   d) Other:_____

2. How many years of experience have you had in your current role?
   Please select the appropriate range:

   a) Less than one year
   b) 1 – 5 years
   c) 6 – 10 years
   d) 11 – 20 years
   e) 21 – 40 years
   f) Over 40 years

3. From your point of view, what are the **general** challenges that the transport/logistics industry, **in your country**, is currently facing?
(no COVID 19 related topics)

4. Does your organization publish an annual sustainability report?
   a) Yes
   b) No

   4.1. If yes, is this report shared and distributed among all of the employees?
      a) Yes
      b) No

5. Is your organization committed towards sustainability in accordance to the United Nations Sustainable Development Goals?
   a) Yes
   b) No
   c) Don't know/No opinion

   5.1. If yes, what do you believe is the area your company is most committed in?
   (please choose one)

      a) Environmental
      b) Social
      c) Economic
      d) All of the above

   5.2. Why do you believe that?

6. In your opinion, what importance does CO_2 reduction (environmental pillar) have for your organization compared to the following factors:
(please set a checkmark ☒)

	More important	Equally important	Less important	**Than..**
CO_2 reduction is …				Profitability
CO_2 reduction is …				Revenue Growth
CO_2 reduction is …				Employee Satisfaction
CO_2 reduction is …				Customer Satisfaction
CO_2 reduction is …				Cost Savings
CO_2 reduction is …				Management Bonus
CO_2 reduction is …				Employee Benefits

7. Did your company adopt strategies concerning the reduction of Greenhouse Gases (main component CO_2, among other gases)?

   a) Yes
   b) No

   7.1. Concerning your transport operations: What do you consider as the **three** most important strategies **decreasing** the CO_2 output, and why? What do you believe is their impact?

What?	Why?	Impact?
1.		
2.		
3.		

8. In your opinion, what does your organization plan concerning further CO_2 reduction in the future?
(please list a maximum of 3)

9. From your perspective, what are the **challenges** for the Portuguese/German transport/logistics sector to reduce emissions?
(please list a maximum of 3)

10. Does your organization use Information and Communication Technology to make transport operations more efficient?
If so, what ones and how do they improve operations?
(please list a maximum of 3)

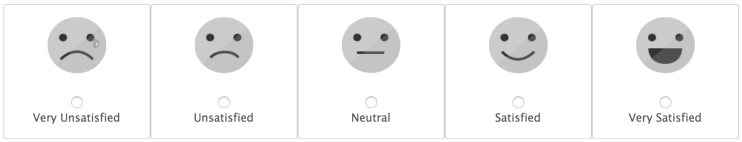
11. What do you believe are the main:
    - **Challenges and costs**
    - **Advantages and motivations**

    When it comes to implementing equipment, processes and tools concerning the reduction of CO_2?
    (please list a maximum of 3)

12. Have you heard of the European Green Deal?
    a) Yes
    b) No

    12.1 Do you believe the set targets for Sustainable Mobility in the European Union can be reached (*90% reduction of GHG in all modes of transport by 2050*)?

13. How satisfied are you with your company's engagement in regard to the social pillar of sustainability (human rights, labor practices, safety, diversity, etc.)?



13.1 In your opinion, where could your company improve, and why?

14. Do you have further comments that may be relevant concerning the subject matter?

Thank you for your participation in this research!

If you are interested in the results of this research, please indicate your email:

_____

Appendix H: Categorization of 'TOP 100 der Logistik'

Potential Case Studies German road transport companies

Comparability	Company Name	Founding Year	Vehicle Combinations	Employees	Main sector of activity	Website	Linkedin Employees/ Potential Interview Part.	Info on Sustinable Development none/bare minimum//medium/ sufficient
2 matching comparability criteria/matching sector of activity/ info on sustainability	BLG Logistics Group AG & CO. KG	1877	Trucks 500 Waggons 1500	11.700 World	B2B - Automobiles, break bulk, electronics & high-tech, sports & fashion, consumer goods, food, machines & systems, sanitary and building technology	https://www.blg-logistics.com/en/our-company/blg-story	600	sufficient https://www.blg-logistics.com/en/our-company/sustainability/sustainability-report-archives
2 matching comparability criteria/info on sustainability	DPD Deutschland GmbH	1976	Trucks 11000	9500	B2B/B2C - Parcel and express freight shipments	https://www.dpd.com/de/de/	510	sufficient https://brandcenter.dpdgroup.com/m/18a8c220a35233ce/original/DPDgroup_CSR-Report_2019.pdf
2 matching comparability criteria/matching sector of activity/ info on sustainability	Hellmann Worldwide Logistics SE & Co. KG	1871	Trucks 5000	10,696 world 5076 Europe	B2B - Agricultural, Automotive, Beverage, Cruise, Fashion, Healthcare	https://www.hellmann.net/en/germany/about-us/	4360	sufficient https://bmp.hellmann.net/documents/Brochure_Global_Sustainability_Report_2018
2 matching comparability criteria/matching sector of activity/ info on sustainability	Hermes Europe GmbH	1972	Trucks 1800 Waggons 7500	5.555 Germany	B2B/ B2C: fashion, sports and games, furniture, beverages	https://www.hermesworld.com/de/ueber-uns/hermes-gruppe/hermes-transport-logistics/hermes-transport-logistics/	740	sufficient https://www.hermesworld.com/de/ueber-uns/verantwortung/klima-umwelt/
1 matching comparability criteria/ info on sustainbility/similar sector of activity	Pfenning Logistics	1932	Trucks 800	3700	automotive, chemistry, pharmacy, Consumer goods and food.	https://www.pfenning-logistics.com/	84	sufficient https://www.pfenning-logistics.com/green-logistics-teil-der-unternehmens-dna/ https://www.pfenning-logistics.com/e-mobilitaet-fuer-lkw-funktioniert/ https://www.pfenning-logistics.com/nachhaltigkeit/
2 factors matching comparability criteria/similar	trans-o-flex Express GmbH	1971	Trucks 2900	2000	B2B/B2C -pharmaceutical, healthcare, beauty and cosmetics, entertainment and	https://www.trans-o-flex.com/trans-o-flex/	139	sufficient https://www.trans-o-flex.com/trans-o-flex/umwelt-verantwortung/nachhaltigkeitsbericht-2/
unclear business structure	24plus Systemverkehre GmbH & Co. KG Cooperation	1996	Short Distance Fleet 1800 Long Distance Fleet 1100 Loading Containers 4000	5500	B2B - small load products, thermo transports	https://24plus.de/company/facts-and-figures/?lang=en	3	
sector of activity	ALFRED TALKE GmbH & Co. KG	1947	Tankers 1200 Silo trucks 310 Containers 840	1600 Europe	B2B - liquid bulk, dry bulk, packed goods	https://www.talke.com/en/transport/liquid-bulk-transport/	286	
no information on sustainability/ specialized on automotive transport	ARS Altmann AG Automobillogistik	1975	Trucks 850 Waggons 3500	1000 Europe	B2B - automotive logistics	https://www.ars-altmann.de/en/home/	69	bare minimum https://www.ars-altmann.de/en/sustainability/
too small	BTK Befrachtungs- und Transportkontor GmbH	1939	Trucks 158 Waggons 200	300	B2B - Complete and partial loads as well as general cargo	https://www.btk.de/fakten	10	bare minimum https://www.btk.de/csr
intransparent information	Bursped Speditions GmbH part of Cooperation Cargo Line	1948	Trucks 4,623	7000	no specific sector of activity	https://www.bursped.de/en/about-us/	26	bare minimum --> Info from 2013 https://www.bursped.de/category/allgemein-de/page/4/
unclear business structure	CargoLine GmbH & Co. KG - cooperation		Trucks 4590 Waggons 3110	7590	B2B/B2C - no specific sector of acvtivity, standardised and systemised groupage transports	https://www.cargoline.de/en/facts-figures/	19	
too large/ international	Dachser SE	1930	no data	16666 Germany	B2B/B2C- Transport and storage of industrial goods, food	https://www.dachser.com/en/index	7167	sufficient https://www.dachser.com/en/ecology-91
too small, no info on sustainability	Johann Dettendorfer Spedition Ferntrans GmbH & Co. KG	1825	Trucks 170 Waggons 320	558	B2B - paper, steel, Automotive, beverages, wood and building materials, consumer goods	https://www.dettendorfer.de/	1	Bare minimum https://www.dettendorfer.de/klimaschutz
too large / international	DB Schenker	1872	no data	17400		https://www.dbschenker.com/de-de/ueber-uns/db-schenker-in-deutschland#:~:text=Die%20Schenker%20Deutschland%20AG%20mit,integrierte%20Logistik%20im%20deutschen%20Markt.	world 32497	
unclear business structure	DIALOG Distribution and Logistics Speditions- und Speditionsberatung AG Cooperation		Trucks 3600	8000	Service portfolio of consumer goods and brands	www.dialog-ag.org	no data	
2 matching comparability criteria/ no info on sustainbility	Thomas Duvenbeck Holding GmbH	1932	Trucks 1,650	6000	B2B - Automotiv, agricultural machinery technology, high-tech, beverage industry	https://www.duvenbeck.de/Spedition	328	bare minimum https://www.duvenbeck.de/Firmenkultur/Verantwortung
1 matching comparability criteria/ no info on sustainbility	Emons Holding GmbH & Co. KG	1928	Trucks 310 Waggons 1160 Extra 1000 trucks daily	3117 world	B2B -Parcel and general cargo shipping mainly Europe	https://www.emons.de/	216	bare minimum https://www.emons.de/unternehmen/umwelt-verkehr/
intransparent information	Fiege Logistik Holding Stiftung & Co. KG	1873	no data	19000 world 7193 Germany	Fashion logistics, healthcare, industry, consumer goods, tire logistics, media logistics and multichannel retail. Mainly Europe and Asia	https://www.fiege.com/country/germany/	1603	none https://www.fiege.com/climate-neutrality-for-a-better-world/
no information on sustainability	Finsterwalder Transport & Logistik GmbH		Trucks 245 (owned)	1700	B2B - Complete and partial loads as well as general cargo	https://www.finsterwalder.com/produkte-service/transports	no data/not on Linkedin	none
2 matching comparability criteria/ no info on sustainbility	Hans Geis GmbH + Co KG		Trucks 2.300 (own and partner)	6473	B2B - Complete and partial loads as well as general cargo in Europe area	https://www.geis-group.com/en/key-figures	29	bare minimum https://www.geis-group.com/de/sustainability
intransparent information/ no information on sustainability	Hansetrans Holding GmbH		Trucks 1200	no data	Transport and forwarding of all kinds of goods, mainly in Germany --> Moving, transport, courier, furniture delivery.	https://www.hansetrans.de/ueber-uns/	2	None
intransparent information/ no information on sustainability	Honold Logistik Gruppe	1879	no data	1400	Aerospace, Agriculture, Automotive, Healthcare, Retail, Metal and Tires.	https://honold.net/	44	none

no information on sustainability/ no contacts for interview	IN tIME Express Logistik GmbH	1987	Trucks 1500	600	Automotive, pharmaceutical and electrical industries	https://www.intime.de/	no data		none
too small --> similar sector of activity/Information on sustainability	Heinrich Koch Internationale Spedition GmbH & Co. KG+B24:B26	1900	Trucks 118 (own) Waggons 696 Carrier Trucks 228	750	Automotive, chemicals, consumer and consumer goods, healthcare / pharmaceuticals, food, mechanical and electrical engineering	https://www.koch-international.de/	21	sufficient	https://www.koch-international.de/fileadmin/user_upload/Nachhaltigkeitsbericht_2018.pdf
too big/ untransparent information	Kuehne + Nagel (AG & Co.) KG	1890		15.000 germany	Automotive, forest / wood, perishables, beverages, high-tech, relief supplies, hotel, industry, FMCG, aerospace, trade fairs and events, oil and gas, pharmaceutical and healthcare, retail / fashion	https://de.kuehne-nagel.com/de_de/landverkehr/	33382	sufficient	https://de.kuehne-nagel.com/de_de/other-links/co2-neutralitat/
1 matching comparability criteria/ not enough info on sustainbility	L.I.T. AG	1988	Trucks 1100 Waggons 2000 Trailer 700	3000	Automotive, steel, chemicals, building materials, beverages and packaging	https://www.lit.de/	15	medium	https://www.lit.de/unternehmen/green-logistics/
specialized sector of activity/ not enough information on sustainability	Meyer & Meyer Holding SE & Co. KG	1902	Trucks 1000 Waggons 2500	1800	Textile and fashion	https://www.meyermeyer.com/de/	125	medium	https://www.meyermeyer.com/de/company/nachhaltigkeit/
specialized sector of activity/ not enough information on sustainability	Ludwig Meyer GmbH & Co. KG	1960	Trucks 1200	1800	food	http://www.meyer-logistik.com/willkommen-bei-meyer-logistik/	14	medium	http://www.meyer-logistik.com/nachhaltigkeit/verantwortung/#p29
specialized sector of activity/ not enough information on sustainability	Nagel-Group SE & Co. KG	1935	Trucks 7,000	13000	food	https://www.nagel-group.com/en/ueber_uns/warum_nagel_group/daten___fakten/zahlen__fakten_1.html	540	medium	https://www.nagel-group.com/en/ueber_uns/nachhaltigkeit/index.html
specialized sector of activity/ not enough information on sustainability	Offergeld Logistik Gruppe	1924	Trucks 500 Trailer 1000	2000	Focus on glass transports. Also automotive, personal care, cleaning agent industries, food, consumer goods, industrial goods	https://www.offergeld.de/de/	50	medium	https://www.offergeld.de/wp-content/uploads/2015/11/Nachhaltigkeitsbericht-2015-AOW-10-2016.pdf
too small/ no info on sustainability	Rieck Logistik-Gruppe		Trucks 600 Trailer 260	700	Automotive, e-commerce, food, high-tech as well as medicine and pharmaceuticals.	https://www.rieck-logistik.de/ueber-uns/das-unternehmen/	no data/not on Linkedin	bare minimum	https://www.rieck-logistik.de/expertise/nachhaltigkeit/
specialized sector of activity /data on vehicle combinations	Rudolph Logistik Gruppe	1946	no data	4500	Automotive, Industry, trade	https://www.rudolph-log.com/home/	160	sufficient	https://datenbank2.deutscher-nachhaltigkeitskodex.de/Profile/CompanyProfile/13646/de/2018/dnk https://www.rudolph-log.com/verantwortung/fuer-unsere-umwelt/
specialized sector of activity/ not enough information on sustainability	Scherm Holding & Verwaltungs GmbH	1972	Trucks 1500 (own and partner)	2000	mainly automotive	https://www.scherm.com/unternehmen/fakten	2	medium	https://www.scherm.com/verantwortung/nachhaltigkeit
specialized sector of activity	Karl Schmidt Spedition GmbH & Co. KG	1948	Trucks 1300	2000	Bulk transport, Silo, Gas	https://www.schmidt-heilbronn.de/leistungen/transport/	5	bare minimum	https://www.schmidt-heilbronn.de/qualitaet/
too big/ data on vehicle combinations	Schnellecke Group AG & Co. KG	1939	no data	19627 world (including agency workers)	automotive and others	https://www.schnellecke.com/willkommen	252	sufficient	https://www.schnellecke.com/media/1920.SEL+NHBericht2018_EN.pdf
too small	Seifert Logistics Group	1947	300 Trucks (own) 295 Trailer	2000	Automotive, building materials, chemical, pharmaceutical, paper industry, trade	https://www.seifert-logistics.com/de/startseite/	102		
too small	Streck Transportgesellschaft mbH	1946	Trucks 521 Trailer 420	1.200	Chemicals and plastics, tool and mechanical engineering, e-commerce, retail, Food, automotive and textile.	https://www.streck-transport.com/home	115	medium	https://www.streck-transport.com/nachhaltigkeit/blue-logistics

COLOR LEGEND:
unclear business structure /too small/ too large/no information on sustainability/specialized sector of activity
1 factor matches comparability criteria/no information on sustainability/specialized sector of activity
2 factors matching comparability criteria/similar sector of activity/ information on sustainability

Appendix I: Questionnaire Template Research Institute

Fraunhofer

Introduction

My name is Alina Mago and the purpose of this questionnaire is to identify challenges of sustainability in the road freight sector, with a focus on the environmental challenges.
The study is conducted with the ISCTE Business School in Portugal, Lisbon, and serves the development of my Master Thesis. The aim of the research is the comparison of Portuguese and German transport practices.

Your participation is voluntary. Your response is based on personal beliefs and will only be utilized for this research. The information obtained will be handled anonymously, and according to the rules of the General Data Protection. It will take approximately 15 minutes to complete the compiled questions.

Thank you for your cooperation!

Definition Sustainability

Sustainability signifies 'meeting the needs of the present without compromising the ability of future generations to meet their own needs' (International Institute for Sustainable Development , n.d.). It is based on the three pillars: economic, environmental, and social.

Challenges of Sustainability in the Road Freight Sector

1. From your point of view, what are the general challenges that the transport/logistics industry, is currently facing?
   (no COVID 19 related topics)

2. In your opinion, should organizations publish an annual sustainability report? And should this report be shared and distributed among all of the employees?
   a) Yes
   b) No

3. Do you believe that organizations should be committed towards sustainability in accordance to the United Nations Sustainable Development Goals?
   a) Yes
   b) No

   3.1. If yes, what do you believe is the area a company should be most committed in? (please choose one)
      a) Environmental
      b) Social
      c) Economic
      d) All of the above

   3.2. Why do you believe that?

4. In your opinion, what importance does CO2 reduction (environmental pillar) have for transport organization concerning road freight compared to the following factors: (please set a checkmark x)

	More important	Equally important	Less important	**Than..**
CO_2 reduction is …				Profitability
CO_2 reduction is …				Revenue Growth
CO_2 reduction is …				Employee Satisfaction
CO_2 reduction is …				Customer Satisfaction
CO_2 reduction is …				Cost Savings
CO_2 reduction is …				Management Bonus
CO_2 reduction is …				Employee Benefits

5. Concerning general transport operations: What do you consider as the three most important strategies decreasing the CO2 output, and why? What do you believe is their impact?

What?	Why?	Impact?
1.		
2.		
3.		

6. Concerning future transport processes in road freight, what do you believe are further measures related towards the reduction of CO_2?
(Please list a maximum of 3)

7. Do you think that information and communication technology helps in making transport processes more efficient? If so, which ones are useful and how can they improve work processes?
(Please specify a maximum of 3 measures)

8. What do you believe are the main:
   - Challenges and costs
   - Advantages and motivations

   When it comes to implementing equipment, processes and tools concerning the reduction of CO2?
   (please list a maximum of 3)

9. Have you heard of the European Green Deal?
   a) Yes
   b) No

   9.1 Do you believe the set targets for Sustainable Mobility in the European Union can be reached (*90% reduction of GHG in all modes of transport by 2050*)? Why?

Appendix J: Questionnaire Answers Summary

Answers Questionnaire – Comparison Sheet of Company Answers

Challenges of Sustainability in the Road Freight Sector

Answers Comparison Sheet

1. What is your current job position in the organization?

   Trans-o-flex: b) Management
   BLG Logistics: d) Other: Project Management Sustainability and Digitalization
   Luís Simões: a) Senior Management
   Paulo Duarte: a) Senior Management

2. How many years of experience have you had in your current role?
   Please select the appropriate range:

   Trans-o-flex: b) 1 – 5 years
   BLG Logistics: a) less than 1 year
   Luís Simões: d) 11-20 years
   Paulo Duarte: d)11-20 years

3. From your point of view, what are the **general** challenges that the transport/logistics industry, **in your country**, is currently facing?
   (no COVID 19 related topics)

   Trans-o-flex:
   Diesel driving bans
   Driver shortage
   Increase in online trade and, as a result, increasing delivery traffic

   BLG Logistics:
   - Meeting customer requirements, keep pace with changing demands
   - Environment and climate protection
   - Economic viability

   Luís Simões:
   → No Challenges mentioned, speaking about business strategy

   Paulo Duarte:
   Labour costs, automation, fuel challenges.

4. Does your organization publish an annual sustainability report?
   Trans-o-flex, BLG and Luís Simões
   a) Yes
   Paulo Duarte:
   b) No

   4.1. If yes, is this report shared and distributed among all of the employees?

Trans-o-flex, BLG, Luís Simões
a) Yes

5. Is your organization committed towards sustainability in accordance to the United Nations Sustainable Development Goals?

Trans-o-flex: b) No
BLG: a)Yes
Luís Simões: a)Yes
Paulo Duarte: a)Yes

5.1. If yes, what do you believe is the area your company is most committed in? (please choose one)

BLG: d) All of the above
Luís Simões: d) all of the above
Paulo Duarte: d) all of the above

5.2. Why do you believe that?

BLG:
In a strategic process, SDGs for all three pillars of sustainability were identified as essential. As a large employer, we have a social and economic responsibilities. In the area of ecology, we have set ambitious goals to reduce our greenhouse gas emissions.

Luís Simões:
Sustainability is one of our main values that guide our business strategy. We implemented different initiatives to contribute to a more sustainable and environmentally friendly logistics and transport model. Among other aspects, the various projects made it possible to reduce CO2e, save costs ´, reduce vehicle fuel consumption and achieve greater energy efficiency in warehouses.

Paulo Duarte:
Future of organizations implies all parties involved

6. In your opinion, what importance does CO_2 reduction (environmental pillar) have for your organization compared to the following factors:
(please set a checkmark ☒)

Trans-o-flex:

	More important	Equally important	Less important	**Than..**
CO_2 reduction is …			X	Profitability
CO_2 reduction is …			X	Revenue Growth

CO_2 reduction is …			X	Employee Satisfaction
CO_2 reduction is …			X	Customer Satisfaction
CO_2 reduction is …			X	Cost Savings
CO_2 reduction is …			X	Management Bonus
CO_2 reduction is …			X	Employee Benefits

BLG:

	More important	Equally important	Less important	**Than..**
CO_2 reduction is …			X	Profitability
CO_2 reduction is …		X		Revenue Growth
CO_2 reduction is …			X	Employee Satisfaction
CO_2 reduction is …			X	Customer Satisfaction
CO_2 reduction is …		X		Cost Savings
CO_2 reduction is …	X			Management Bonus
CO_2 reduction is …	X			Employee Benefits

Luís Simões:

	More important	Equally important	Less important	**Than..**
CO_2 reduction is …		X		Profitability
CO_2 reduction is …		X		Revenue Growth
CO_2 reduction is …		X		Employee Satisfaction
CO_2 reduction is …		X		Customer Satisfaction
CO_2 reduction is …		X		Cost Savings
CO_2 reduction is …		X		Management Bonus
CO_2 reduction is …		X		Employee Benefits

Paulo Duarte:

	More important	Equally important	Less important	**Than..**
CO_2 reduction is …		X		Profitability
CO_2 reduction is …		X		Revenue Growth
CO_2 reduction is …		X		Employee Satisfaction

CO_2 reduction is …		X		Customer Satisfaction
CO_2 reduction is …		X		Cost Savings
CO_2 reduction is …	X			Management Bonus
CO_2 reduction is …		X		Employee Benefits

7. Did your company adopt strategies concerning the reduction of Greenhouse Gases (main component CO_2, among other gases)?

Trans-o-flex, BLG, Luís Simões, Paulo Duarte

a) Yes

7.1. Concerning your transport operations: What do you consider as the **three** most important strategies **decreasing** the CO_2 output, and why? What do you believe is their impact?

Trans-o-flex:

What?	Why?	Impact?
1. Reduction of vehicles	Increase of efficiency	CO2 reduction by increasing the degree of capacity utilization of the vehicle, thus the number of vehicles used
X Optimization of transport routes	Increase of efficiency	CO2 reduction by minimizing transport routes and thus fuel/energy
X Use of alternatively powered vehicles	Savings of fossil fuels	Reduction of CO2 emissions through the use of non-fossil fuels

BLG:

What?	Why?	Impact?
X Modernization of the truck fleet	Modern trucks with efficient engines (>99% EURO 6)	The specific diesel consumption [l / 100km] of our own truck fleet has been decreasing since 2014
X Telematic systems/ Driver training	Feedback and optimization of driving style	The specific diesel consumption [l / 100km] of our own truck fleet has been decreasing since 2014
X Alternative driving systems	Utilization of fuel with less CO2/kwh	The specific diesel consumption [l / 100km] of our own truck fleet has been decreasing since 2014

Luís Simões:

What?	Why?	Impact?
X	Renewal of the refrigeration fleet with the acquisition of modern vehicles, with more cooling gases, environmentally friendly	Reduce CO2
X	Reduce vehicle fuel consumption	Save costs and reduce CO2
X	Greater energy efficiency in warehouses	Save costs and reduce CO2

Paulo Duarte:

What?	Why?	Impact?
1.Eco-Driving	Less fuel consumption, less CO2 ,	Environment and profit
X More Efficient trucks, Newer	Less fuel consumption, less CO2 ,	Environment and profit
X Best Optimization Lesst empty kms	Less fuel consumption, less CO2 ,	Environment and profit

8. In your opinion, what does your organization plan concerning further CO_2 reduction in the future?
(please list a maximum of 3)

Trans-o-flex:
- Increase of efficiency
- increased use of reusable consumables
- Use of renewable energies

BLG:
- Increase in energy efficiency / use of alternative drives
- Own electricity production
- Purchase of green electricity

Luís Simões:
Innovate to build the future. Luis Simoes success is in every km traveled, in each pallet and each boy moved throughout our history.

→ not answering the question

Paulo Duarte:
Increase relation between CO2 reduction and operations.

9. From your perspective, what are the **challenges** for the German transport/logistics sector to reduce emissions?
(please list a maximum of 3)

Trans-o-flex:
- So far there is no alternative to fossil fuels
- Increase in online trade and thus an increase in the number of transports
- Customers are not ready to bear the increased costs of sustainable transport

BLG:
- Implementation of measures with constant profitability
- Current dependence on fossil fuels to realize the transport volume due to:
    1. Economy
    2. Lack of infrastructure

Luís Simões:
European and international policies demand CO2 emission reduction, which is why companies need to strategically position themselves. Thus, companies need to identify how the framework will affect their business, and which innovative processes would be possible to develop to maintain/increase competitiveness in the future.

Paulo Duarte:
No added value for those who invest in cleaner equipment's;
No reduction of taxes for best practices

10. Does your organization use Information and Communication Technology to make transport operations more efficient?
If so, what ones and how do they improve operations?
(please list a maximum of 3)

Trans-o-flex:
- computer-aided route optimization
- Algorithm for quantity forecast for production planning
- Use of traffic information for optimal route selection

BLG:
Yes, the truck driver receives feedback on driving style, current consumption, etc. via telematics system. This enables the calculation of the specific diesel consumption of our truck fleet.

Luís Simões:

Innovation in technology and process design was another pillar in focus in 2019. We have invested in different developments to foster agile and flexible logistics chains guaranteeing the maximum profitability for our customers operations. We highlight the incorporation of automated systems in warehouses, the implementation of Soft Expert system for automation of administrative and management processes.

Paulo Duarte:
Yes
Best softwares Fleet management;
More control of activities; GPD and Events control;

11. What do you believe are the main:
    - **Challenges and costs**
    - **Advantages and motivations**

    When it comes to implementing equipment, processes and tools concerning the reduction of CO_2?
    (please list a maximum of 3)

Trans-o-flex:
-

BLG:
Challenges & costs: partly Change of structure & processes necessary, high initial investment, selection of different options for action

Advantages & motivations: Cost savings through lower energy requirements, contribution to the achievement of the company's own climate goals, customer acquisition

Luís Simões:
→ not answering the question

Paulo Duarte:
Investing more in more expensive equipment , and no benefit on that.

12. Have you heard of the European Green Deal?

Trans-o-flex, BLG, Luís Simões:

a) Yes

Paulo Duarte:
b) No

12.1 Do you believe the set targets for Sustainable Mobility in the European Union can be reached (*90% reduction of GHG in all modes of transport by 2050*)?

Trans-o-flex:
No - unless there is an alternative to fossil fuels, the goals cannot be achieved.

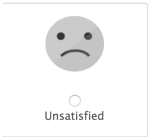
BLG:
Yes, but significant investments in infrastructure and technology are required (both by government and businesses).

Luís Simões:
We believe it is still possible, but we need to increase the implementation process and commitment of governments and companies

Paulo Duarte:
-

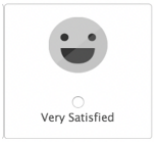
13. How satisfied are you with your company's engagement in regard to the social pillar of sustainability (human rights, labor practices, safety, diversity, etc.)?

Trans-o-flex:

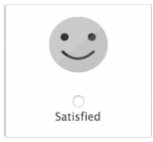


BLG:

Luís Simões:



Paulo Duarte:



13.1 In your opinion, where could your company improve, and why?

Trans-o-flex:
- Targeted implementation of sustainability measures
- Setting a firm target for CO2 reduction

Luís Simões:
The 9 principles, the material themes and the respective UN SDG are the focus of the development and evolution of LS sustainability strategy (always based on transparent communication as a value in the relationship with the community). LS stands for its involvement in the value chain and proximity to the customers in jointly aligning on more sustainable services. Our performance is evaluated annually.

→ not answering the question

Paulo Duarte:
More efficient mindset and controlling activity.

14. Do you have further comments that may be relevant concerning the subject matter?
-

Appendix K: Questionnaire Answers Research Institute

Challenges of Sustainability in the Road Freight Sector

Answer Fraunhofer Institute

1. From your point of view, what are the general challenges that the transport/logistics industry, is currently facing?
   (no COVID 19 related topics)

   - Lack of young drivers among drivers (high average age combined with unattractive working conditions)
   - Strong cost pressure from customers
   - Difficulties in medium to long-term planning of investment decisions due to hesitant climate policy (exception: determination of CO2 prices)
   - Automated driving (platooning): Will the legislature support this technology and if so, when can you start planning with it?

2. In your opinion, should organizations publish an annual sustainability report? And should this report be shared and distributed among all of the employees?
   a) Yes

3. Do you believe that organizations should be committed towards sustainability in accordance to the United Nations Sustainable Development Goals?

   a) Yes,
      Although the SDGs go much further than they are relevant for most companies (e.g. security of water supply, etc.)

   3.1. If yes, what do you believe is the area a company should be most committed in? (please choose one)

      d) All of the above

   3.2. Why do you believe that?

      Without sustainable economic development, it will be difficult to invest in ecologically sound technologies early on and to adapt processes. Social sustainability is a plus point when looking for motivated and committed junior employees, especially in times of staff shortages.

4. In your opinion, what importance does CO2 reduction (environmental pillar) have for transport organization concerning road freight compared to the following factors:
   (please set a checkmark x)

	More important	Equally important	Less important	**Than..**
CO_2 reduction is …		X		Profitability

CO_2 reduction is …	X			Revenue Growth
CO_2 reduction is …	X			Employee Satisfaction
CO_2 reduction is …		X		Customer Satisfaction
CO_2 reduction is …		X		Cost Savings
CO_2 reduction is …	X			Management Bonus
CO_2 reduction is …	X			Employee Benefits

5. Concerning general transport operations: What do you consider as the three most important strategies decreasing the CO2 output, and why? What do you believe is their impact?

What?	Why?	Impact?
1.	Conversion to low-emission drives (for long-distance transport as an interim solution liquified Natural Gas (LNG), in the medium term either Battery Electric Vehicle (BEV) or hybrid overhead line technology; for distribution transport BEV)	With BEV 100% emission savings, with HO trucks depending on the infrastructure being equipped with overhead lines
2.	Avoidance of empty trips and optimization of vehicle loading (e.g. via freight exchanges and digital platforms)	Increase of efficiency
3.	Use of combined road-rail transport where possible	Increase of efficiency

6. Concerning future transport processes in road freight, what do you believe are further measures related towards the reduction of CO_2?
(Please list a maximum of 3)

   - Softening the rigid regulation on dimensions of the trailer (adaptation of the shape of the trailer for better aerodynamics and adaptation to volume-critical goods)

7. Do you think that information and communication technology helps in making transport processes more efficient? If so, which ones are useful and how can they improve work processes?
(Please specify a maximum of 3 measures)

Yes: digital freight exchanges, generally automated and networked driving, platooning

8. What do you believe are the main:
   - Challenges and costs
   - Advantages and motivations

   When it comes to implementing equipment, processes and tools concerning the reduction of CO_2?
   (please list a maximum of 3)

   - Lack of infrastructure for alternative fuels plus disincentives (subsidies for diesel taxation).

   - Hydrogen: From today's perspective, hydrogen will never be able to be produced cheaply enough (as green H2) to make the technology competitive in the truck sector.

9. Have you heard of the European Green Deal?
   a) Yes

   9.1 Do you believe the set targets for Sustainable Mobility in the European Union can be reached (*90% reduction of GHG in all modes of transport by 2050*)? Why?

   Yes, because without appropriate incentives (e.g. diesel taxation), alternative drives will be more cost-effective than conventional drives and the optimization of efficiency means a cost and competitive advantage for the transport company at the same time. To do this, however, politicians must set the course at an early stage and invest in the development of the infrastructure (fast charging infrastructure along the highways plus overhead line technology).

   Achieving the 90% will be difficult through air traffic and sea traffic, because there the investment cycles in aircraft and ships are at least 30 to well over 50 years and it is therefore impossible for all vehicles to be retrofitted by 2050, even if it is already fictitiously corresponding today low-emission or even zero-emission technologies existed.

   However, road traffic is feasible.