Comparison of diesel and electric trucks in the transportation company

Case Solid Way OY

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Description

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Abstract

Current economies are constantly growing, and business environment is changing consequently. Logistics operations are being actively affected by the sustainability megatrend, as the need for green transportation solutions has emerged. That is why the fleet choice plays an essential role in logistics organizations providing transportation services. It leads to better planning of resources and workload, customers satisfactions and compliance with regulations. In order to follow the sustainability trend, the comparison of diesel and electric trucks was conducted at the request of the company.

The factors influencing the choice of transport technology and the extent to which they have an impact on this choice were analysed. Furthermore, the environmental impact of diesel and electric trucks in a Finnish transport company was examined by the researcher. The methodology recommended by the European Commission was used for the emission calculation. The objective of the study was to compare the electric truck and current diesel-powered fleet from several perspectives in order to found out the most reliable and valid technology on the current market. As a result, the suitable driveline has been chosen for the company.

During the research process, the mixed research approach which included parts of quantitative and qualitative research methods was utilized by the author. The theoretical part of the study was based on a literature review, interviews, and surveys which helped to answer the research questions. Based on the collected information, the author was able to conduct a case study as well as analyse the performance and usage of different technologies on the current market.

The results of the case study helped to choose the most suitable technology for the case company in order to cover the needs of its customers. However, the case study results cannot be generalized because they were highly customized for a target organization and adjusted to the operating environment. Additionally, implications for further research and recommendations for the company were provided.

Keywords/tags (subjects)

Transportation Industry, Road Freight and the Environment, Green Logistics, Electric and Diesel Trucks

Miscellaneous (Confidential information)

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1 Introduction

1.1 Background information and motivation for the research

Nowadays, transportation is a crucial part of current economies and societies as well as a significant contributor to global emissions. Companies should consider not only the profitability aspect in organization activities but also sustainable development in this dynamic business environment. As the need for green transportation solutions continues to grow and against the background of increasing governmental and public concern for the environment, companies are looking for different solutions in order to decrease their activities' impact on the ecology (McClelland, 2021).

The concept of green logistics is included as a crucial component in the transportation sector as a foundation balancing business requirements, customers' needs satisfaction, and sustainability principles. It refers to changing the transportation chain to burden the environment as minimally as possible. In recent years, the use of electric vehicles is increasing as a promising alternative to traditional diesel-powered vehicles in order to lower emissions.

The adoption of electric fleets in the transportation sector has been slower than anticipated, primarily due to their higher upfront costs, concerns about their viability, needed maintenance, operations, and haulage that could appear while utilization of these vehicles for delivering cargo. There is just limited research on emissions, investments, operating costs and the environmental impact of diesel and electric trucks in the transportation industry. Therefore, the motivation for this research is to deepen the studies on the mentioned aspects, evaluate and compare the specified types of vehicles from several factors and choose the most suitable driveline for the transportation company currently operating on the Finnish market.

1.2 Short explanation of Solid Way OY business framework

Solid Way Oy is a logistics company located in Finland that offers services on the international and domestic levels. Founded in 2013, the company has developed rapidly and now operates a fleet of modern vehicles, providing efficient and reliable transportation solutions for its customers. The company has a team of experienced logistics professionals who work in close cooperation with customers to understand their specific requirements and offer customized solutions that meet

their unique needs. The company is located in Kotka, which allows it to offer forwarding and warehouse services for cargo traffic from Europe, the USA, Southeast Asia, and Latin America in transit within Finland to Russia. Currently the company owns diesel-powered fleet in order to perform its operations in transportation.

Solid Way Oy performs on the market successfully due to having a solid foundation of professionalism, reliability, and innovation. The organization is continuously exploring innovative technologies and approaches to develop its operations and services and offer its customers the best possible transportation solutions. In the current sustainability trend, the company is looking for a solution to reduce its carbon footprint by investing in modern fuel-efficient trucks and trailers or any existing alternatives.

1.3 Research objectives and questions

The goal in this research is to compare diesel and electric trucks from several aspects including the economic considerations, environmental concerns, technological advancements, legal, social, and political perspectives and provide recommendations regarding the choice of the driveline based on vehicle's relevance and appropriateness. The study is focused on the Finnish market and is conducted for the transportation organization located in this country and operating in the specified industry sector.

Research questions:

1. What are the impacts of diesel and electric trucks of company's operations on the environment in terms of greenhouse gas emissions?
2. What factors influence the usage and performance of diesel or electric trucks in the Finnish company nowadays and what are the impacts of these aspects?
3. What driveline should a company choose for road transportation on the current market?

The choice of comparing diesel and electric trucks for Solid Way OY on the current market is relevant and novel, as transportation companies are actively looking for sustainable logistics options

to reduce their impact on the environment and comply with emissions regulations. Multidimensional perspective would be considered in the research by the author for providing findings and results, that would represent valuable recommendations and would contribute to the development of field of study. The research will provide an extensive and versatile study of electric and diesel fleet in the context of company Solid Way Oy.

1.4 Limitations and delimitations

Regarding limitations, it is worth mentioning, that the research is focused on the perception of European vehicle manufacturers and their products. As the electric fleet is an innovative technology that is still under piloting processes and is supposed to be a competitive product of the manufacturer, certain characteristics and figures could be presented approximately. Moreover, analysis of the environmental impact of the vehicle could be limited by the availability of relevant formulas, tools, and technical expertise.

There are some delimitations in the study:

1. It will not be focusing on any other types of vehicles except diesel and battery-powered ones.
2. It will not consider truck manufacturers and their products from outside the European Union.
3. It will be focused on the regulations and laws regarding the road transport sector only in Finland.
4. The results of the study could apply only to case-specific vehicles and companies.

2 Road cargo transport sector in Finland

2.1 Current state

The Finnish Road transport sector is well-developed and plays a significant role in transportation infrastructure, the country's economy, and everyday life, supporting businesses, other industries, and individuals. Finland has an extensive and well-maintained road network, which covers approximately 450 000 km in total. Players of different ranges and purposes starting from small owner-

operators and ending with global international companies are included in the transportation industry sector.

The transportation industry is dominated by trucks, which deliver approximately 90% of the goods. It is the most common, easily fulfilled, and fast way of transporting goods within Finland for geographically decentralized industry and settlement (Logistiikan Maailma, 2023). Due to the high demand for transportation services in the country, this sector is constantly developing and growing on the market, and additionally, it contributes to the generation of revenue for the Finnish economy and job creation.

2.1.1 Key players

This sector is highly competitive in Finland: truck manufacturers, logistics companies, and producers of equipment perform as key players in the mentioned sector. One of the biggest logistics companies operating in this sector is Posti Group which offers its customers a wide range of services in delivering goods and covers most of parcel deliveries in Finland utilizing several types of fleets.

Among truck manufacturers providing their products on the Finnish market, three main competitors could be listed: Volvo, Scania, and Mercedes-Benz. Mentioned manufacturers offer a wide range of heavy-duty vehicles for different purposes of transportation. Generally, based on statistics, 2 526 new trucks were registered in Finland in 2021. The figure below represents the share of first-time registration by brand (Carlier, 2023).

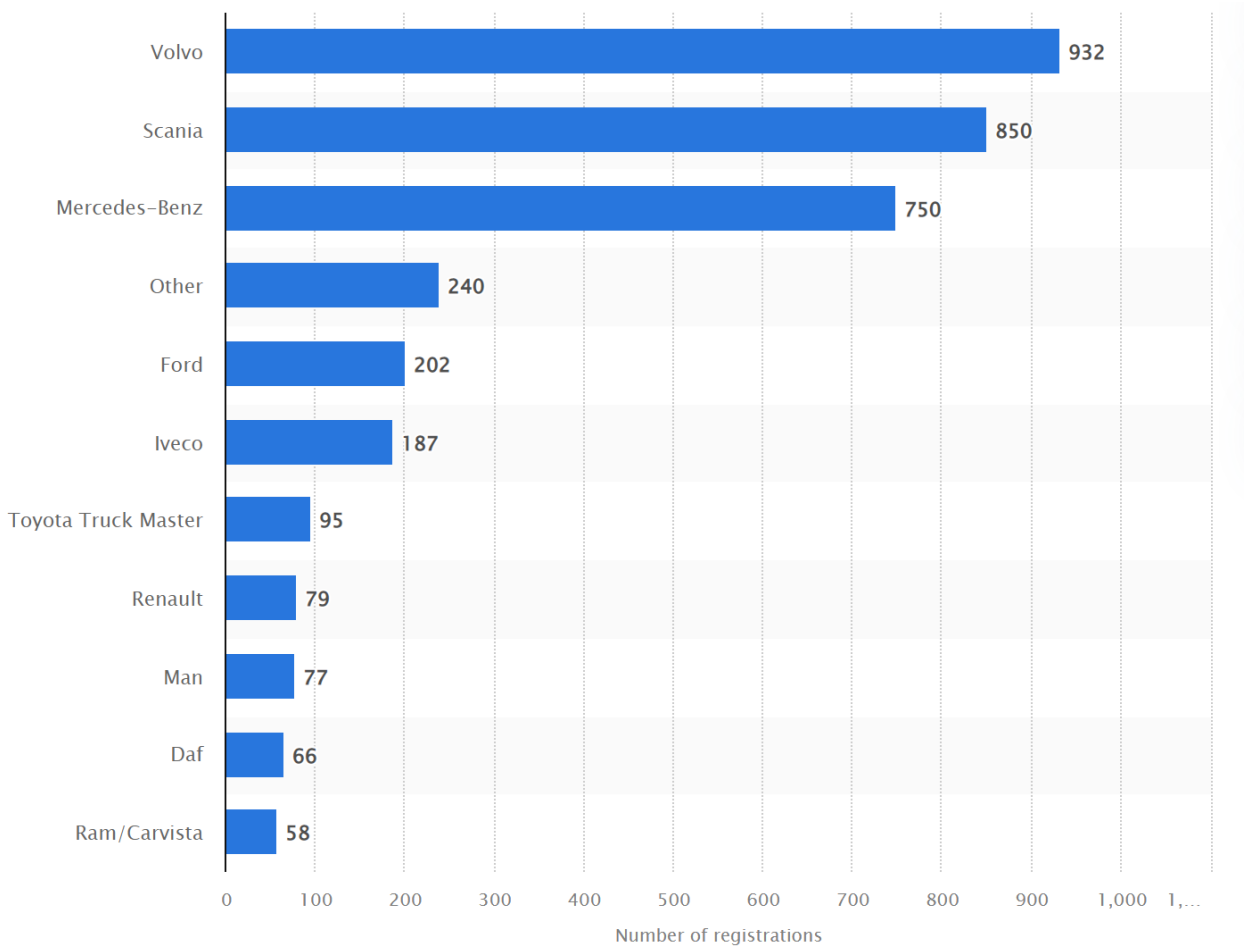

Figure 1 Number of new registrations of trucks in Finland in 2021, by brand (Statista, 2023)

2.1.2 Policy framework and regulation

A range of regulations and government policies are applied in Finland in the road cargo transportation sector, which should be considered in business operations. The Road Traffic Act streamlines regulations and is considered as a significant deregulation project. A set of norms and requirements for road transportation is provided in the document for enabling smooth flow and safe traffic within the country and creating conditions for safe automation of transport and digitalisation. The new Road Traffic Act entered into force on 1 June 2020 and met the requirements set by international agreements and EU legislation (TRAFICOM, 2023).

Another important policy in cargo transportation corresponds to environmental regulations affecting the industry and introduces limitations on carbon emissions. One notable example is Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 setting CO2

emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC. As Finland is part of the European Union, it should meet the guideline of the presented directive (European Union, 2019). Reduction of emissions in the logistics sector is presented as a key focus in the mentioned document, that is why nowadays different transportation organizations are looking and trying different solutions in order to decrease emissions and become the future carbon-neutral company.

Additional directives are presented in order to support and promote the path towards sustainability in European Union:

- The Energy Efficiency Directive (EED) - intended to reduce the EU's total energy consumption at least by 32.5% by 2030;
- The Renewable Energy Directive (RED) – intended to shift from crop-based biofuels such as palm oil towards cleaner and renewable energy sources;
- The Energy Performance of the Buildings Directive (EPBD) – intended to introduce charging stations or enable the installation of ducting infrastructure in parking areas in the long-term perspective;
- Market Design Directive and Regulation – intended to install smart metering systems in using electricity, that would enable consumers to use energy without redundant chargers (Virta Global, 2022).

Another important aspect that is regulated by policies in cargo transportation is allowed dimensions and weights. For national and international transport EU has presented in 1996 „The Weights and Dimensions Directive ", however, based on the directive, all countries included in the EU can define their limits for vehicles on the national level. Finnish Transport and Communications Agency Traficom has increased the maximum limits for mass and main dimensions of the vehicle and vehicle combination, as presented in Road Traffic Law 729/2018 (Ely-keskus, 2023).

Labour regulations are put in place as well and provide policies regarding employment conditions, salaries, and rights of employees engaged in regional, foreign, and domestic freight transport.

Finnish Transport Workers' Union AKT-ry negotiates and presents a collective agreement (Finnish Transport Workers' Union, 2023).

The presented regulatory frameworks define conditions designed for promoting safe, efficient transportation that is followed by environmental concerns. Companies operating in the presented industry should meet all the requirements and policies in order to stay competitive on the market. Regulations support the development of a country's economy and can be amended depending on the needs and changes in the world.

Another important aspect regarding regulations in the road freight industry in Finland is the taxation system. The responsible authority is the Finnish Transport and Communications Agency, which calculates the rates for different types of vehicle and bills logistics companies. The taxation system is usually updated annually and includes various aspects, which would be presented further. According to the Finnish Transport and Communications Agency (2023), "the annual vehicle tax for trucks is composed of a tax on driving power plus, in some cases, an additional drawbar tax. Tax on driving power depends on the vehicle's number of axles, total mass, and possible use for pulling a trailer or semi-trailer." It would worth noting that taxations system is same for heavy-duty trucks despite different nature of sources of power.

2.2 Impact of road freight on the environment

A wide variety of externalities such as air pollution, greenhouse emissions, vibration, and noise could be found in logistics operations. Nowadays the concern regarding climate change is growing as the most serious ecological challenge, that is why it is crucial to examine how logistics operations impact the environment.

According to McKinnon, Browne, Whiteing & Cullinane (2015) emissions from road transportation directly depend on the used fuel type. Nowadays the most common one is diesel, which produces pollutants such as carbon monoxide, nitrogen oxides, and hydrocarbons due to the incomplete combustion process in machine's engines. Along the same line Dr. Rodrigue (n.d.) subsequently argued that the mentioned emissions could cause extreme weather conditions, the rise of sea

level, and pollution on local, regional, and global levels. Moreover, these small particles impact human health and could cause different respiratory problems. Therefore, the road transportation sector is becoming highly linked to ecological problems.

Moreover, the heavy-duty vehicle could cause vibration that might result in damage to roadside buildings and infrastructure. There are various levels of damage: architectural and structural, where the first one relates to interface cracks, while the second one leads to serious destructions in the building itself, that cause risk of collapse or subsidence. It is stated that the vibration is usually caused by the fluctuations of wheel contact load, which could be minimized by maintaining smooth road surfaces (McKinnon et al, 2015).

Road freight transportation is producing noise pollution as well, which is considered to be continuous and tends to be a more severe problem than noise caused by any other transport mode. Mostly this aspect affects individuals that may have problems with sleep disturbance, annoyance, concentration problems, etc. It has been researched, that there are three noise generators: propulsion noise, aerodynamics noise, and tire-road-contact noise. Most recently Regulation 540/2014 has introduced new limits for levels of noise value, which will become in force as of 2016, 2022, and 2026 (Academy of European Law, 2023).

As noted by McKinnon et al (2015), congestion is also an existing problem, that results in time losses, extra operating costs and contribute to excessive fuel usage, which causes air pollutant and greenhouse emissions. Congestion is defined as the situation when vehicles impose on each other when the use of a transport system achieves its capacity. Driving at lower speeds cause a notable rise in emissions. The impact of vehicle's velocity on CO2 emissions per kilometre is shown in Figure 3. A broader perspective has been adopted by Engström (2016), who argues that congestion affects economic competitiveness and efficiency, reduces society value and logistics operations reliability, and increases organizational costs.

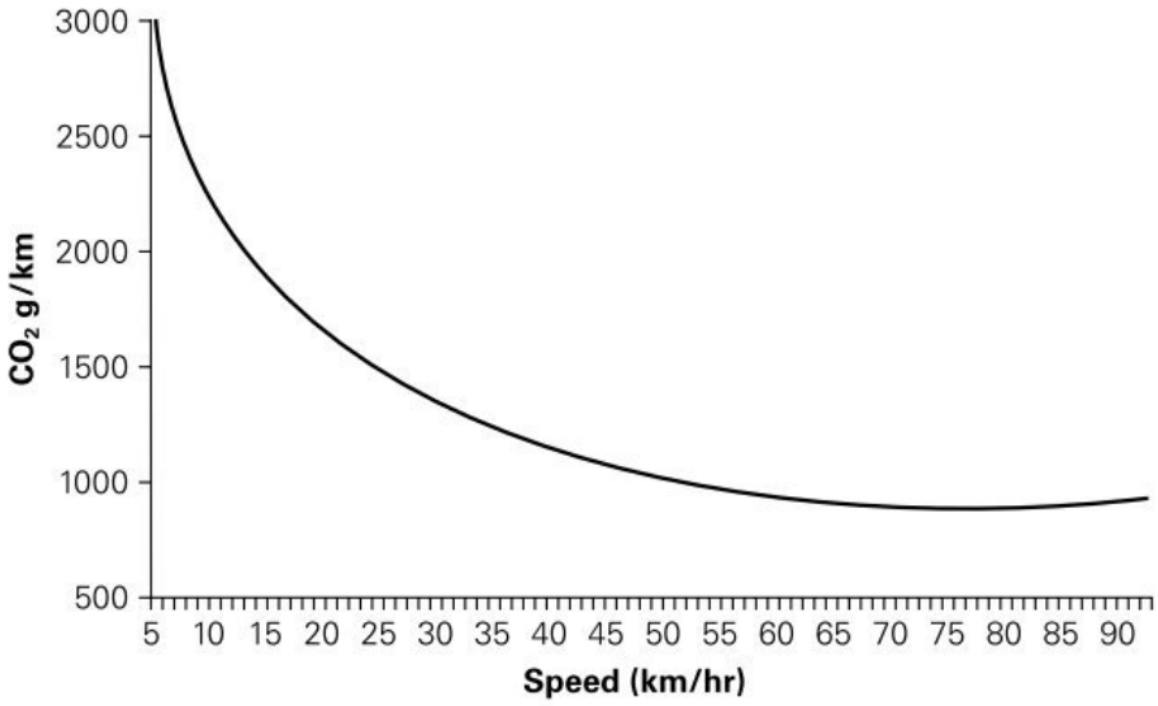

Figure 2 Vehicle Speed and CO2 emission - articulated vehicle over 40 tonnes gross vehicle weight (McKinnon,2015)

Considering the evidence presented in this chapter, the road cargo transport sector plays a significant role in supply chains, enabling the movement of goods across long distances. However, this industry seriously affects the environment, causing air and noise pollution, greenhouse emissions, vibration, and congestion. Therefore, there is a need to solve the emerging problems and reduce the footprint on the ecology. It is beneficial not only for the planet and future generations but also may tend to cost saving and performance improvement of organizations through adaptation of new practices, implementing innovative technologies and route optimization.

2.3 Emerging trends in road transportation

The world and the environment are constantly changing, developing, and evolving. That is why at the same time businesses follow the changes in order to meet customers' needs. Moreover, companies always depend on the government, as that constantly presents new regulations, restrictions, guidance, and legislation. Currently, there are a couple of emerging trends in the transportation industry in Finland. They would be described shortly further.

According to Paloneva and Takamäki (2021), the main trend emerging in transportation reflects a strong commitment towards sustainability and reduction of environmental impact. Finland's strategy regarding climate and national energy has proposed the goal to cut in half the number of emissions from transport in 2005 by 2030 and eliminate emissions by 2045. A step towards carbon-neutral transport is represented as the main path of the target. In the Finnish Government Programme adopted in 2020 it is highlighted that country strives to be carbon neutral by 2035. However, it could be noted that proposed policies and plans for reducing emissions are in unlikelihood to be sufficient and met the goals if the expectations on how emerging economies are evolving rapidly and how the need for transport services is increasing from year to year become true. That is why the accurate analysis and considerations of all emerging megatrends and developments in different areas should be included in action plans towards sustainable future.

There is a growing trend towards digitalization implementation in logistics management and physical deliveries in the cargo transportation industry. It offers a wide range of solutions such as reverse logistics, route optimization, and driver assistance systems and enables eco-friendly, efficient, and platooning technologies in-vehicle networks, which would make a great contribution to emission reduction by 15-30%. The process requires investments and consists of multiple steps, where the main one focuses on the introduction and installation of digital logistics solutions and various driver systems (Finnish Central Organisation for Motor Trade and Repairs,Association of Automobile Industry in Finland,Finnish Bus and Coach Association,Association of Automotive Technical Societies in Finland, Finnish Transport and Logistics, Finnish Taxi Owner's Corp, 2020, p. 38).

DHL (2023) has highlighted that the concept of shared cargo transportation and collaborative logistics is spreading nowadays. Currently, there is no straightforward way or formula to estimate the potential emission reduction from these concepts, but there is no doubt that this trend would contribute to mitigating the harmful consequences on the ecosystem. Being more flexible, offering reduction of expenses and risks, and becoming more sustainable are enabled for companies through implementation of shared economy in their strategies and operations planning. A broadly similar point has also recently been made by Ocicka B. and Wieteska G (2017), who highlighted the decarbonization and reduced road congestions benefits through sharing facilities and transport vehicles among companies. Authors considered the sharing economy concept as a phenomenon

that drives the development in terms of ecological aspect. Collectively, these studies provide important insights of new concept in logistics as a sustainable possibility for performing transportation operations.

Furthermore, there is an emerging interest in the usage of alternative fuel and electric trucks in the cargo transportation sector. There are already some finish companies that start using electric trucks for delivering goods for short distances, and at the same time, some organizations started experimenting with biofuels, such as biogas and hydrogen.

3 Green logistics

The logistics industry is developing rapidly due to being an important part of every supply chain. However, this rapidly growing sector is linked to trading pollution, emissions, and resource consumption in the operating environment. With the rising responsibility and awareness of the impact on the ecological environment organizations have started considering not only minimizing costs and maximizing profit, but also the development of environmentally friendly operations. Therefore, there is an emerging focus on “green” solutions that move economy towards sustainable logistics systems.

3.1 Green logistics concept

According to Rodrigue, Slack & Comtois (2001), the concept of green logistics was presented in 1972 as a new model that could be promoted in the logistics sector followed by the implementation of innovations and advanced facilities for increasing the productivity of the system and reducing the damages caused by a wide range of operations to the ecological environment. The innovative approach is considered to integrate ecological objectives into the companies’ values and strategy. In the same vein, McKinnon et al (2015) in the book “Green logistics: Improving the environmental sustainability of logistics” note that green logistics, also known as sustainable logistics, consists of a set of activities and operations related to the information, flow of goods, and needed services in the supply chain processes from the beginning to the final consumption point. The main purpose of the described approach is to ensure logistics operation with minimal costs followed by environmentally friendly practices and sustainable development at every stage of the process.

According to Ittmann (2011), green logistics is recognized as an attempt to lessen external aspects and reach a more ecologically responsible balance between social, economic, and environmental objectives. Furthermore, the concept of green logistics is studied as a path to minimize the ecological and energy harms of a supply chain, which is focused on material handling, product distribution, packaging, and delivery.

The concept of green logistics is based on three pillars: environmental, economic, and social, which are interconnected between each other. While considering environmental sustainability, the minimization of negative impact on the ecology should be considered. Practices such as the usage of renewable energy, reduction of pollution, generated waste and emissions, are supposed to be implemented in the organization's operations. Social sustainability focuses on social responsibility in logistics activities and covers aspects such as safety in the work environment, human rights, and fair labour practices. Economic sustainability considers the viability of logistics operations which includes boosting efficiency, optimizing supply chains, and decreasing delivery costs. These three concepts create the framework for organizations, in which they could positively influence the development of the economy and society, remain competitive on the market, and promote sustainability and responsibility (McKinnon et al., 2015).

According to Anil Kumar (2015), two key factors motivate organizations to "green" their logistics operations. The first is the environmental concern and the second is marketing demands. Researcher supposed that most companies promote their green image through their logistics management just to enhance their reputation in society since products manufactured in a green way are becoming an emerging trend nowadays with massive consumption in the world.

Ecological concerns and environmental responsibility are increasingly crucial factors affecting the competitiveness of road transport organizations. Businesses and customers are becoming more environmentally conscious and are looking for companies that prioritize sustainability in their logistics activities. As a result, road freight organizations that fail to meet environmental concerns may face decreased demand for the provided services and could struggle to remain stable in the market. At the same time, companies that have already started prioritizing sustainable performance could be more competitive in the market as they may be more attractive to customers who are looking for environmentally friendly services and products.

Nowadays green logistics is a hot topic for research and implementation which promotes addressing environmental issues at various levels and stages. However, El-Berishy, Rügge, and Scholz-Reiter (2013) have highlighted that there are some barriers and challenges that could be faced at the implementation stage in the organization. There are internal and external reasons. Internal barriers are connected with high implication expenses and investments, lack of skills and knowledge, shortage of human and financial resources. External ones may include a lack of support and interest of customers, businesses, and companies operating in the same environment as well as a lack of governmental support structure, uncertainty, and market competition.

3.2 Zero emission

Cutting GHG emissions to as close to zero as possible followed by re-absorbing the remaining emissions by forests and oceans from the atmosphere is a desired goal nowadays. United Nations (n.d.) have stated, that while greenhouse gases emissions have grown slowly over the past decade in comparison with the previous one, in the last decade GHG emissions on average were recorded the highest. In comparison to the 2.6% per year between 2000 and 2009, the average growth between 2010 and 2019 was 1.1 % yearly. Our planet is reacting even to minor changes in the amount of methane, CO_2, and other harmful gases in the atmosphere, that is why emissions of these gases should be decreased or even excluded until the whole ecosystem will return to balance. Along the same line UNEP (2022) has highlighted in the research, that “as of 23 September 2022, 88 parties covering approximately 79 percent of global GHG emissions have adopted net-zero pledges either in law (21 parties), in a policy document such as an NDC or a long-term strategy (47 parties), or in an announcement by a high-level government official (20 parties)” (p. 21). This has started up the way towards carbon neutrality on the formal basis among a wide range of countries in the world.

The net-zero emission concept means that all human-produced pollutants should be removed from the atmosphere in order to stabilize temperature and climate in general. This objective has been clarified by Switzerland, the European Union, and other countries participating in Paris Agreement (MyClimate, 2023). The shift towards a climate-neutral society could be challenging, however as a result it is a great possibility to build a better world for future generations. According to European Commission (2023), “the EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions. This objective is at the heart of the European Green Deal and

in line with the EU's commitment to global climate action under the Paris Agreement." It is crucial that all parties of economic and social sectors would be involved in the process, otherwise, the transition will not be effective, and the result will not be achieved. This process would need huge investments into innovations, novel solutions in technology and facilities, into research and study projects reinforced by governmental policies and regulations. EU Member States should work on the development of long-term strategies on national level, on how they are going to reduce green-house gases emissions required to correspond to their commitments under EU objectives and the Paris Agreement.

To achieve the goal and close the emission gap between total global greenhouse gas emissions and the goal of the agreement, several sectoral transformations should be implemented and put in action by 2030 leading to net zero emissions in the long perspective. It could be challenging as the transformation would be implemented simultaneously in areas such as powering houses, transporting goods and people, offering services, growing, consuming food, and managing supply chains and logistics operations. The changes should include refusing fossil fuels, electrifying fleets, stopping deforestation, and retrofitting housing. This shift should be started in all countries and in all industries parallelly, even if the sequence of actions may slightly differ in countries. (UNEP, 2022).

Transportation industry is the second-largest contributor of CO2 emissions on the global level, contributing 25 percent of total emissions related to energy (International Energy Agency, 2021). According to UNEP Emissions Gap Report (2022) changes in the transportation sector include a change in modes of fleets for low-emitting ones, an acceleration of the shift towards zero-carbon vehicles, and preparations for the move to zero-carbon shipping and even aviation. Actions that hasten or hinder changes in the transportation sector are presented in the Figure 4.

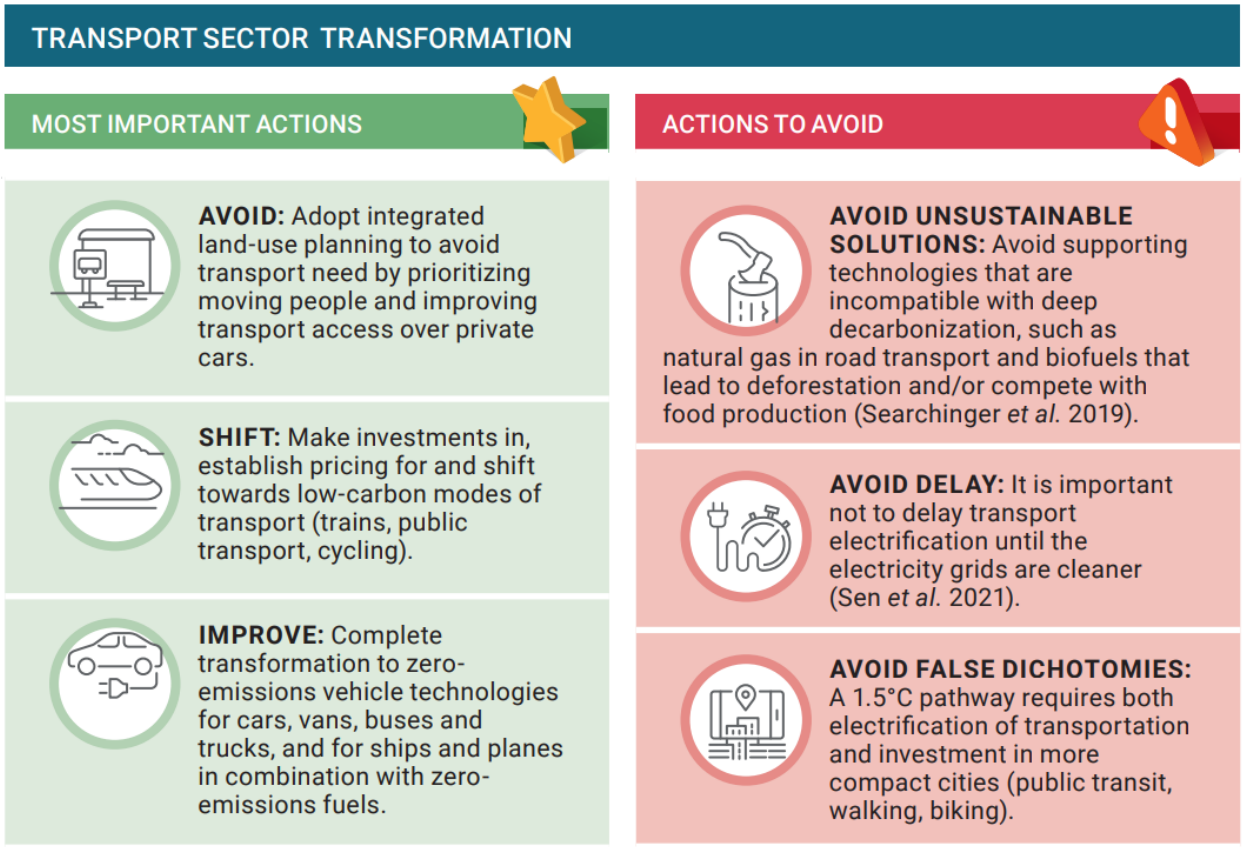

Figure 3 Actions accelerating the transformation of the transport sector (EGR, 2022)

For enabling the previously mentioned actions it is recommended setting some initiatives on the national level. A shift towards zero-emissions cars, trucks, and vans sales could be promoted by governments, regions, and cities through presenting strict limitations on CO2 emission of new trucks, so the manufacturer would be forced to follow them in order to keep their position in the market. Additionally, it could be followed by regulations and policies in biofuels, green hydrogen, and renewable energy industries. Furthermore, the taxation system should be aligned to support environmental objectives and values. Lastly, Governments should invest in infrastructure that would ensure zero-emission transportation of products (UNEP, 2022).

4 Truck and transport vehicle technology

Every year, freight vehicles carry more than a hundred thousand pounds of products across the world. The trucks used in this delivery process consume a significant amount of fuel and are responsible for about one-third of all fuel usage, leading to a significant contribution to emissions.

There has been a growing focus on the development of vehicle technologies in the cargo transportation sector that are more efficient and less polluting, as well as the promotion of alternative modes of transportation. Nowadays several types of trucks are used in logistics for carrying cargo.

4.1 Diesel truck

Diesel trucks represent heavy vehicles that are commonly used in the transportation and logistics industry. They are known for fuel efficiency and increased torque that is making diesel cars an ideal choice for transporting heavy loads over long distances. Additionally, it is a reliable technology, which is well-known by a specialist, so in case of emergency, the company will not struggle with maintenance and repair operations (Lynch Truck Center, n.d.).

For a diesel engine to function, it requires a combination of diesel fuel and O2, with the combustion process resulting in the production of CO2 within the engine. The rise in global cargo transportation has highlighted the significant impact of diesel engines on the environment overall. Additionally, since diesel fuel is derived from non-renewable oil, it is expected to be depleted eventually unless its usage is significantly reduced.

4.1.1 Euro emission standard for diesel trucks

According to The Association for Emissions Control by Catalyst AECC (n.d.), the Euro emission standards are a set of regulations that intoduce limits on the number of pollutants that can be emitted by vehicles sold in the European Union. The Euro emission standards for diesel engines have been in place since 1992, with each subsequent version of the standards becoming stricter. The latest version of the standards, known as Euro 6, is in place since the first of January 2013 and applies to all new diesel vehicles sold in the EU. In particular, Euro 6 sets limits on nitrogen oxides, particulate matter, carbon monoxide, and hydrocarbons, and requires vehicles to have more developed emissions control mechanisms, such as selective catalytic reduction systems and diesel particulate filters, to meet these limits. Emission standards are considered to be a crucial part in the path towards sustainable logistics operations. This is correlated with the data obtained from European Commission (n.d.), who noted that the reduction of transport-related greenhouse gas emissions is being positively affected by the introduction of standards for diesel trucks' emissions.

Since the introduction of the Euro standards, nitrogen oxides (NOx) limits for heavy-duty engines have been decreased by 95%, and those for particulates (PM) by 97% (The Association for Emissions Control by Catalyst, n.d.). The figure below represents the development of euro emission standards for diesel engines.

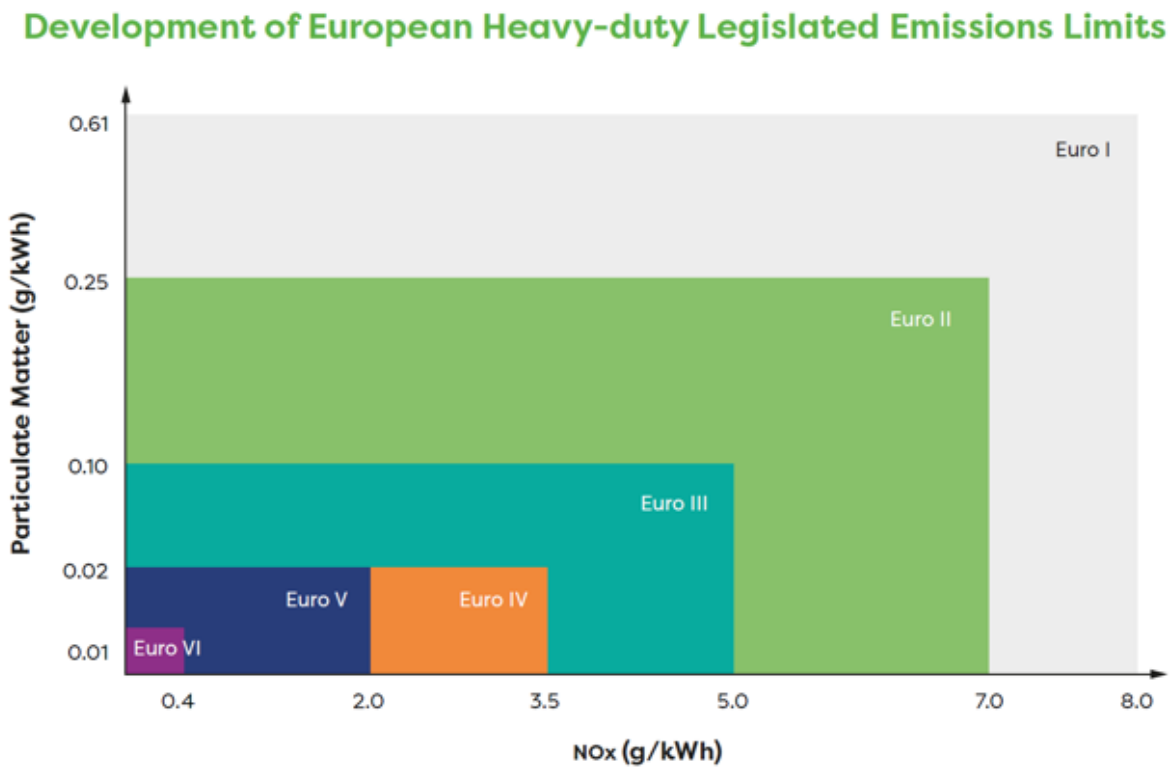

Figure 4 Development of European Heavy-duty Legislated Emissions Limits (AECC, 2023)

For transportation and logistics companies it is important to meet requirements provided by European Union. According to Eurol Lubricants (2021), in order to reduce the emissions diesel exhaust fluid (DEF), also known as AdBlue, is utilized in heavy-duty diesel trucks, because such vehicles typically produce higher levels of nitrogen oxides compared to other types of vehicles. “Adblue is a clear liquid, suitable for the treatment of exhaust gases in order to ensure to meet the emission standards” (Eurol Lubricants, 2021, p. 1). While the use of AdBlue has helped to significantly reduce emissions from diesel trucks and improve air quality, it has caused some additional expenses and maintenance requirements.

4.1.2 Diesel fuel price

Diesel trucks are relying on fuel prices, as the cost is one of the most important valuable for logistics firms and individual truck drivers. Europe's fuel costs have changed throughout the past few years due to a variety of factors, including domestic and international taxes, levies, supply and demand, and governmental regulations. Consequently, for trucking firms and individual truck drivers, the volatile nature of European prices poses a serious issue because they must carefully control their fuel expenditures to stay viable and profitable on the market (UTA, 2023).

4.2 Electric truck

Electric truck is a new and rapidly evolving technology that is beginning to change the transportation industry. Unlike traditional diesel-powered trucks, electric trucks use batteries or other electrical storage systems to power their engines, which enables the reduction of emissions and carbon footprint. It is believed that electric trucks will play a significant role in the Paris agreement's aim of ensuring that global warming will not get more than 1,5 degrees Celsius (Volvo, 2023). It is worth noting that despite a decrease in CO2 emissions, the electrification of trucks enables noise reduction and decouples the vehicle from the energy source, as it is independent of weather carbon-based fuel, nuclear or weather energy was used for a plug-in (Folkson & Sapsford, 2022).

Different organizations in the transportation sector becoming more conscious of the sustainability concept, which prompts them to look for environmentally friendly alternatives such as electric trucks, which could enable more clean and ecological services within the cargo-delivering process.

Although electric trucks are considered to be a greener trucking technology, they can pose several problems in practice. Compared to diesel trucks, electric trucks have a limited range because they cannot travel more than 300-400 km without stopping to recharge. This means that for transporting products over long distances optimization of routes is needed to guarantee that the necessary infrastructure is in place to reach the final destination. It is also important to consider the required time for transportation, as the time needed to recharge the battery can make it difficult to use electric trucks for long-distance transportation (Cunanan, et al., 2021).

Moreover, electric trucks are limited in weight and load size because of their heavier weight, as the battery system is integrated into the truck design, so their overall payload capacity may be limited, and technology cannot be used for certain types of cargo freight.

4.2.1 Electromobility

Electric trucks relate to the concept of electromobility, which promotes eco-friendly and quiet transportation. Electromobility could be a CO2-neutral solution, while it is powered by renewable energy. Low-emission vehicles would positively affect not only the planet's climate but also humans' health and well-being (eMobility, 2023).

It is crucial to remember that the designation of electric vehicles as zero-emission technology is dependent on their being powered by green energy sources. Given that renewable energy accounted for just 29 percent of electricity production in 2020 in Europe, it is not yet possible to view electric vehicles as a completely carbon-neutral technology in the nearest future. Nowadays most energy is produced from nuclear power or fossil resources. (Center for Climate and Energy Solution, n.d.). However, it is worth mentioning, that according to Ministry of Economic Affairs and Employment of Finland (n.d.) nowadays "renewable energy sources represent about forty percent of energy end-consumption" in the country and by 2030 its target is to increase it to fifty percent. The country has several renewable energy sources such as wood-based fuels, hydro and wind power, geothermal and solar power, that creates reliable base for promoting adaptation of electric trucks which could be powered in a sustainable way.

While diesel trucks are directly connected to the price of fuel, electric vehicles depend on electricity prices, which are fluctuating nowadays due to several reasons. Prices on public stations depends on the operator, the provided charging level, time of the day etc. As there is the growing trend to attract people to move from diesel and petroleum, some charging stations offer several loyalty programmes, annual charging subscriptions and discounts.

4.2.2 Electric truck infrastructure

According to ACEA (2021), approximately 40,000 battery electric medium- and heavy-duty vehicles are expected to transport cargo in Europe by 2025, whilst in 2030 this figure is supposed to increase to approximately 270,000, which could be seen in Figure 6. That would require needed infrastructure for ensuring the smooth delivery of cargo. In order to consider higher power demands of heavy-duty vehicles, three categories could be defined based on power range: below 350 kW, 350-500 kW, and above 500 kW. Based on the assumptions and plans, up to 350 charging stations should be placed in Finland by 2030, which requires investments and governmental financial support.

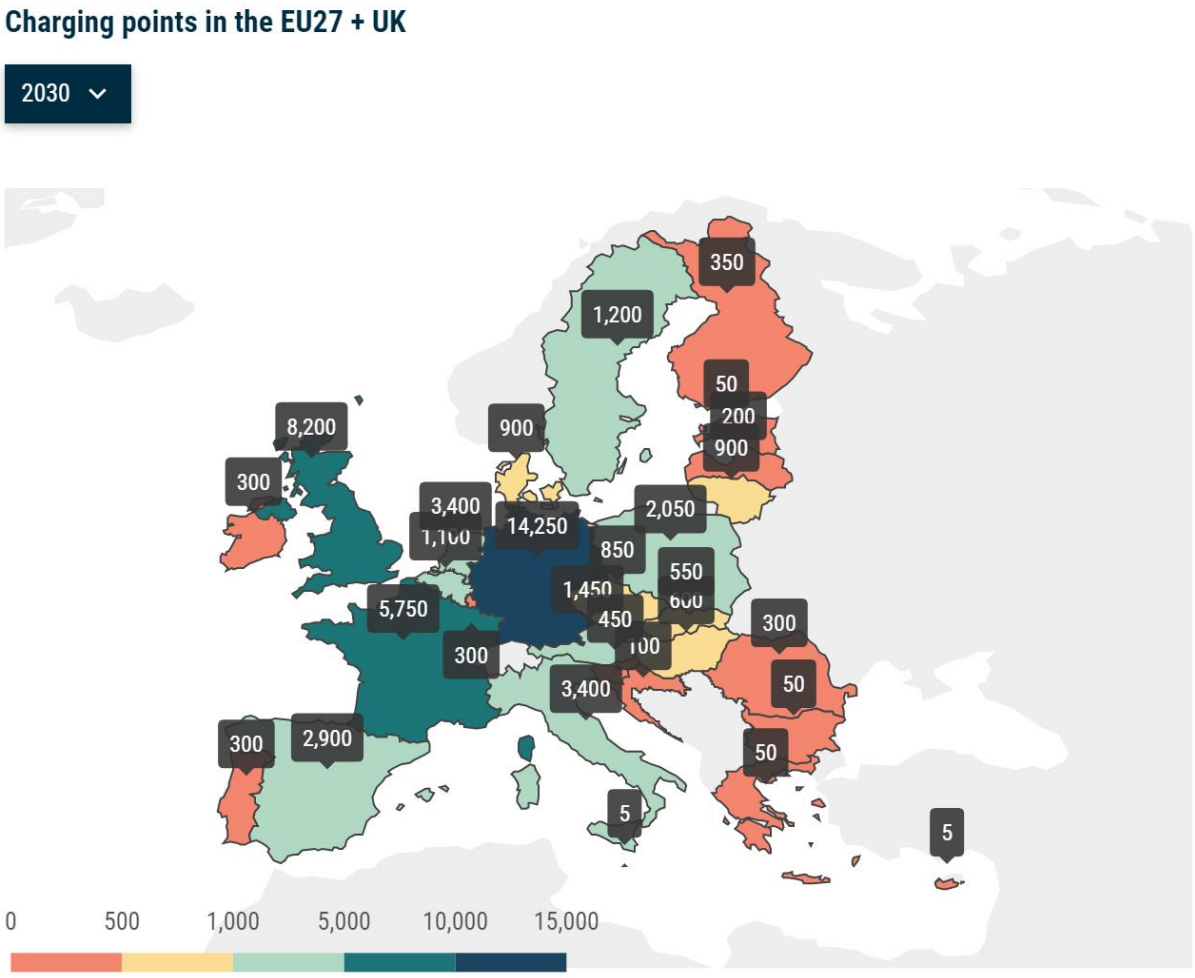

Figure 5 Charging station in the European Union by 2030 (ACEA, 2021)

Even though the installation of the charging station is difficult and could be challenging in northern regions, it is still cheaper than constructing a gas station at place. For ensuring safe and proper installation of the charging point it is highly recommended to hire a professional. Location is the main aspect that should be considered while installing the station (Virta Global, 2022). As we are considering the truck transportation sector, that delivers goods, it is better to correlate construction of e-stations with the Trans-European Transport Network and mostly used roads for transporting goods on national level.

4.2.3 Incentives for electric vehicles

Finnish Central Organization for Motor Trade and Repairs et al (2020) has stated that financial incentives have been introducing in many European countries for buying low-emission vehicles in recent years. It has been done for closing the gap between the prices of vehicles with the latest technologies and conventional models to make modern cars financially attractive to customers. Usually, these incentives are set in the form of purchase grants, tax relief or lower running costs. It is stated that the government should align the taxation system and cut down the tax on low-emission vehicles as soon as possible.

Finnish Government has put in force the act on purchase and conversion subsidies for low-emission vehicles. The President of the Republic approved the act on 22 December 2021, and it was published and entered in force on 1 January 2022. The purchase and conversion grants will encourage individuals and businesses to shift from fossil fuels towards alternatives, that would significantly reduce emissions in transportation sector. Electric and gas vehicles of all types may enter the second-hand fleet market after a while, so that would lead to spreading these technologies to societies more and more. Currently, these incentives could be implemented for purchasing passenger cars, vans and even trucks (Ministry of Transport and Communications, 2021).

According to Ministry of Transport and Communication (2021), “there are six subsidy paths to get the grant from the government for purchasing low-emission vehicle:

- new subsidy for purchasing an electric van;
- new subsidy for purchasing a gas-powered van;
- new subsidy for purchasing an electric truck;

- continuation of the present purchase subsidy for full electric passenger cars;
- continuation of the present conversion subsidy for passenger cars;
- continuation of the current subsidy for purchasing a gas-powered truck”

The Finnish Transport and Communications Agency Traficom is the responsible authority for providing grants to organizations and people. While purchasing van or truck, it is important to inform and ask for subsidy before purchasing the vehicle, however the grant for the passenger car could be received only after the purchase. It is stated that in 2022 the budget for the mentioned purposes was approved by Parliament and it was 6 million EUR (Ministry of Transport and Communications, 2021).

5 Methodology

5.1 Research concept

Research is an academic activity that is performed for finding information on a specific topic in order to search for solutions to different problems and questions. Since research is a systematic approach, it contains steps that should be followed throughout the process. There is a great number of research approaches, that are dependent on numerous factors such as research request, data availability, and similar variables (Kothari, 2004). The basic research concept was created throughout the years, and it includes five main steps:

1. Research questions identification
2. Research tools elaboration
3. Data collection
4. Data analysis
5. Developing conclusion

(Bell, Brymar, & Harley, 2019)

5.1.1 Source related data types

While conducting a study, a huge amount of data was collected from various sources. It is important to differentiate the applied data for the validity and quality of the research. Two types of data could be used in study implementation.

The first data type is the primary one. It represents information that is collected afresh and for the first time, so it is supposed to be original. It differs based on the gathering method, as it could be done by own collection of data, by observation or recording, by direct communication with respondents through personal interview or any other form. The other type of data is secondary. It refers to information that was gathered by someone and that was gone through the statistical and analytical processes. It is necessary to use secondary data from relevant and qualified resources for making a reliable study in the research field. Alternatively, to avoid unreliable data sources it is worth taking a critical approach to identify inaccuracies and mistakes (Kothari, 2004).

5.1.2 Research types

Nowadays three types of research based on their characteristics and purposes could be highlighted: qualitative, quantitative, and mixed. Usually, the researcher chooses either a qualitative or a quantitative method, based on the goal of the study, however sometimes the studied case should be examined from a distinct perspective, combining elements of both approaches, so in that situation, the mixed approach is utilized.

The qualitative approach represents a strategy, where the researcher emphasized words rather than numbers in the process of collecting and analysing data. It is a subjective and exploratory type of study, where the main purpose is to understand, interpret, and describe the meaning and experiences of individuals or groups. This approach means that data is collected through participant observations and interviews, then it is analysed by themes from descriptions by informants, by content and thematic analysis, and reported (Bell, Brymar, & Harley, 2019).

Quantitative research represents an approach that attempts to measure, count, and analyse phenomena and relationships connected to them. It is a numerical and objective type of research, where the entire process follows statistical rules, and all steps are regulated by precise rules,

therefore ensuring the reliability and validity of the results. This approach means that data is collected by measuring things, analysed through numerical statistical comparison, and reported in a statistical interface (Bell, Brymar, & Harley, 2019). For providing more details and for better visualization of the differences between the two aforementioned research approaches a table below could be used.

Quantitative	Qualitative
Numbers	Words
Point of view of researcher	Points of view of participants
Researcher is distant	Researcher is close
Theory testing	Theory emergent
Static	Process
Structured	Unstructured
Generalization	Contextual understanding
Hard, reliable data	Rich, deep data
Macro	Micro
Behaviour	Meaning
Artificial settings	Natural settings

Figure 6 Contrasting features of quantitative and qualitative research (Bell, Brymar & Harley, 2019)

While there are many differences between qualitative and quantitative research there is a mixed approach, where elements and points of the mentioned types are overlapped and combined. A mixed approach is used when the main goal is to explore a research problem in depth followed by the statistical data. This method is considered to be reliable, and it has recently become a more common approach as it can highlight the strengths of both traditional methods as well as compensate for their weaknesses (Bell, Brymar, & Harley, 2019).

5.1.3 Case study as a research method

The case study methodology entails the detailed and intensive study of a particular case or phenomenon. This approach is concerned with the complexity and particular nature of the case problem or question. In a case study, a researcher is focused on the analysis of a particular situation such as a single organization, single event, specific location, or individual. This method represents

a way of research through which several qualitative and quantitative techniques may be combined, thereby avoiding a great reliance on a single one. This study strategy includes creating a research design, collecting data, and in-depth investigation. That is why a case study can use multiple sources of data and multiple methods in its collection (Bell, Brymar, & Harley, 2019).

Among the key feature of the case study methodology, it is worth mentioning the contextual analysis, as it is focused on the unique context in which the problem or question is examined, including cultural, political, social, historical, and environmental factors. Moreover, an inductive approach is the most commonly used one in the research, meaning that based on the collected data and further analysis new theories, suggestions and explanations are developed (Bell J. , 2006).

There are several advantages of case study research. Benefits include the flexibility in data collection methods through various tools, the ability to capture the context and explore the relationship or phenomena within the framework, which would provide a detailed picture. On the other hand, there are some drawbacks. Limitations of the case study include the difficulty in generalization of the results, lack of data collecting skills, and risk of bias, as the researcher's opinion and vision could influence the result (Bell, Brymar, & Harley, 2019).

5.1.4 Data gathering methods

Data gathering is the process of collecting necessary information, using different methods and sources. A proper data collection strategy is essential for conducting adequate research because it makes it possible to achieve research objectives and find solutions to research problems.

Interview

An interview is a great way for collecting primary data. It involves a discussion between the researcher and the individual whose expertise is needed for the investigation. The possibility to discuss and negotiate the study's topic in a natural setting is provided by interviews. When it is reasonable for the researcher to think that the opinions and knowledge of another person are important, an in-person or telephone interview is used as the research method. This can influence

the outcomes and success of the research, as well as aid to build a comprehensive snapshot. Interviews could be divided into three groups: structured, semi-structured, and unstructured interviews. (Kothari, 2004).

According to Kothari (2004), structured interviews consist of pre-defined questions, so the researcher follows a rigid procedure, asking questions in the form and order planned. As against it, the unstructured interview represents flexibility in the questioning approach. There are no limitations on the types of questions, making topical discussion and the sharing of information easier. Semi-structured interview combines principles of both previously explained types, as there is a predetermined framework for questions, but the researcher has the freedom to add supplementary questions for deepening knowledge and could change the order of questions.

Questionnaires

Questionary research means collecting information about a group of people through questions and analysing the results further. It includes a set of questions in a defined order presented in a form. The questionary is sent to the respondents that supposed to answer the questions on their own. There are three main elements: general form, question formulation and wording, question sequence, that should be considered at the creating stage. It is important to carefully construct the survey and present questions clearly, so respondents will understand them and provide exact answers. This method of gathering information provides an adequate time framework for the participants to answer the questions without pressure, however, it is recommended to set up some deadlines for the respondents, otherwise, the researcher could lose control over this data-gathering method. (Kothari, 2004).

Literature review and document studies

Literature reviews and document studies are commonly used methods of collecting data for research. When researchers conduct a literature review or document study, they are looking for information that already was published on a particular area of interest in their field of study. Due to the availability of free information sources with big data collections, finding information for a liter-

ature review is easy nowadays. Reading newspapers, books, various reports, scientific papers, articles, and many other sources—both in hard copies and online on the internet—can be used for data collection. Moreover, the researcher could examine the company's internal or external papers for information collection with the owner's permission. In addition, the author has the option to ask the research group for historical data on an organization, however, this information may be limited and private (Bell, Brymar, & Harley, 2019).

6 Research

The research represents the case study, in which mixed approach is used and primary and secondary data is examined. Overviewing literature and existing documents, arranging surveys, and conducting interviews were completed in the study for achieving the research objectives and answering the research questions. Research and development competence of the research's author is demonstrated through careful implementation of the selected methods.

Literature and document review was conducted for gathering insights and data regarding current state of the examined technology. Official government websites, academic studies, and company's reports were analyzed for getting a comprehensive understanding of the current state of knowledge, available studies and information for building up a strong foundation for the research. For fulfilling the work, the survey was chosen as another data collection method for gathering the opinion of company's customers for providing the social perspective for examined technologies. The questions for the survey could be found in Appendix 3.

Finally, several interviews have been carefully planned and executed for gathering valuable information, perspectives, and insights. It is a form of collecting primary data, which allows the researcher to gather firsthand information directly from key stakeholders. Interviews had a semi-structured form, meaning that several questions were planned by the author of the research beforehand, however the interviewees answer flexibly, allowing to learn more about the subject. Moreover, in order to fully obtain an in-depth viewpoint on the topic, follow-up questions were also added based on the responses. In the conducted research interviews were organized with the Finnish truck manufacturer, industry insider, CEO of Solid Way Oy and representative of the Finnish transport and communications agency Traficom. The way of data gathering and the respondent's choices have provided an opportunity to acquire expert insights from individuals who have

in-depth knowledge and experience in the trucking industry in Finland. The questions for the interview with truck manufacturer and industry insider could be found in Appendix 1, with company representative in Appendix 2 and with Traficom's worker in Appendix 4. The chosen methods were implemented with attention to details and correlation to the research objectives contributing to the overall quality and rigor of the research.

The study familiarized with the current situation of Solid Way OY, particularly with operations and business requirements in Finland, which includes container transportation to Vaalimaa from ports in Helsinki and Kotka for transporting cargo with different weights. The focus was on the current diesel fleet that is used for logistics processes and on the electric truck, which is supposed to be an ecological alternative. According to CEO of the organization, sustainability is a concern for big customers and clients as they have the budget for it, so there is a trend for choosing transport subcontractors with newer fleets and ecological solutions. In his opinion, the worst impact on the environment in the company's operations is done by diesel-powered trucks, so the main focus is to try to get rid of older trucks and acquire a newer fleet. The owner of company has noted that the company has developed significantly and has capital for investing in modern technologies and facilities that would help to lessen the environmental footprint of operations.

The purpose of the research was to provide Solid Way Oy the current state of both technologies and compare them from political, social, environmental, technological, and legal perspectives and suggest the driveline for the company in choosing the fleet for the current market. Therefore, the research method contained:

- Gathering and analysing background information of company's environment. This allowed to understand the workload and cargo flow.
- Overviewing existing literature on the topic. This allowed to have external opinion of experts on the examined topic.
- Conducting interviews with industry insiders, truck manufacturers, legal representatives. This step allowed to deepen knowledge in different perspectives regarding analysed fleet and current state of the Finnish market.

- Gathering company's customers opinion regarding fleet, clients' fears and wishes. Through surveys it was possible to get information about customers awareness of sustainability and their readiness to move to alternatives.
- Performing emissions calculation that shows the picture of carbon footprint of logistic operations of Solid Way OY.
- Comparing both technologies (electric and diesel) based on available information, correlating the results to Solid Way Oy requirements. It represents the qualitative analysis, and it was done through PESTLE analysis which provides clear overview from several perspectives on fleet.

The above-mentioned theoretical parts provide better understanding of the current road freight state, explain the concept of green logistics, that is focused on moving to more sustainable logistics operations, and explain main aspects of the examined technology, therefore providing solid background for the research.

7 Analysis

7.1 Solid Way OY requirements

Solid Way Oy is located in Kotka and mostly specializing in container cargo road transportation from ports in Helsinki and Kotka to the border between Finland and Russia, so that means that the distances are 400 and 140 km respectively if we consider the full delivery cycle. The total weight of cargo could be from 10 tonnes up to 26 tonnes based on the clients' request. In most cases, the returning trips are empty-running, thus means the trucks do not transport any products except the empty container itself, as that should be returned to the port, which is a huge down point in efficiency. Currently Solid Way OY owns diesel-powered fleet that meets Euro 6 standards.

7.2 Emission calculations

While considering the utilization of diesel and electric truck it is worth calculating the carbon footprint of the mentioned technologies. In these calculations the focus would be on pollutants that emerge while transporting process. Regarding electric vehicles it is worth saying that they do not emit neither greenhouse gas emissions nor air pollutants based on the truck manufacturers' statements. This technology could be net-zero; however, it requires source for charging, which could be

powered by different resources, so the emissions associated with charging an electric truck vary from case to case. In this research the charging process's emissions are not considered.

The information of vehicle fuel that the transportation company is using currently would provide data regarding carbon emission. According to the interview with the company representative, the petroleum diesel is used in the vehicles, so the emission factor is 2,68 kg/l (GHG Protocol, 2017). According to European Commission guideline for Using official statistics to calculate greenhouse gas emission (2010), the formula for calculating emission is:

- *emissions = activity data * emissions factor*

Generally, in transportation industry the activity data could be represented as the total fuel consumption, which could be calculated by the formula:

- *fuel consumption (litres) = total distance (km) * fuel efficiency (litres/km)*

Moreover, the weight of the transported cargo significantly affects the fuel consumption, therefore based on the information gathered from company's fleet, the fuel consumption of loaded truck at average is 43 l/100 km of truck transporting empty container – 31 l/100 km. Emissions of two common routes of Solid Way OY are presented in the table below.

Table 1 CO2 emissios results

Location of Port	Emissions of loaded truck (from port to the border)	Emissions of truck with empty container (from border to port)	Total emissions
Kotka	79 kg CO2	59 kg CO2	138 kg CO2
Helsinki	226 kg CO2	163 kg CO2	389 kg CO2

The environmental impact of a single container delivery could be seen from Table 1. Based on analysis of the last year operations, one truck has made up to 270 deliveries on different routes in

a year, so that corresponds up to seventy-five tonnes of CO2 emissions at average per year, that is a significant impact on the environment from the diesel vehicle.

7.3 PESTLE analysis

According to the University of Sydney (2023), PESTLE is a tool used for creating a macro picture of the business environments. It examines the new business idea from political, economic, social, technological, legal, and environmental factors. It is a useful tool for the organization for forming an impression of several aspects that impact the new perspective at the current and future states.

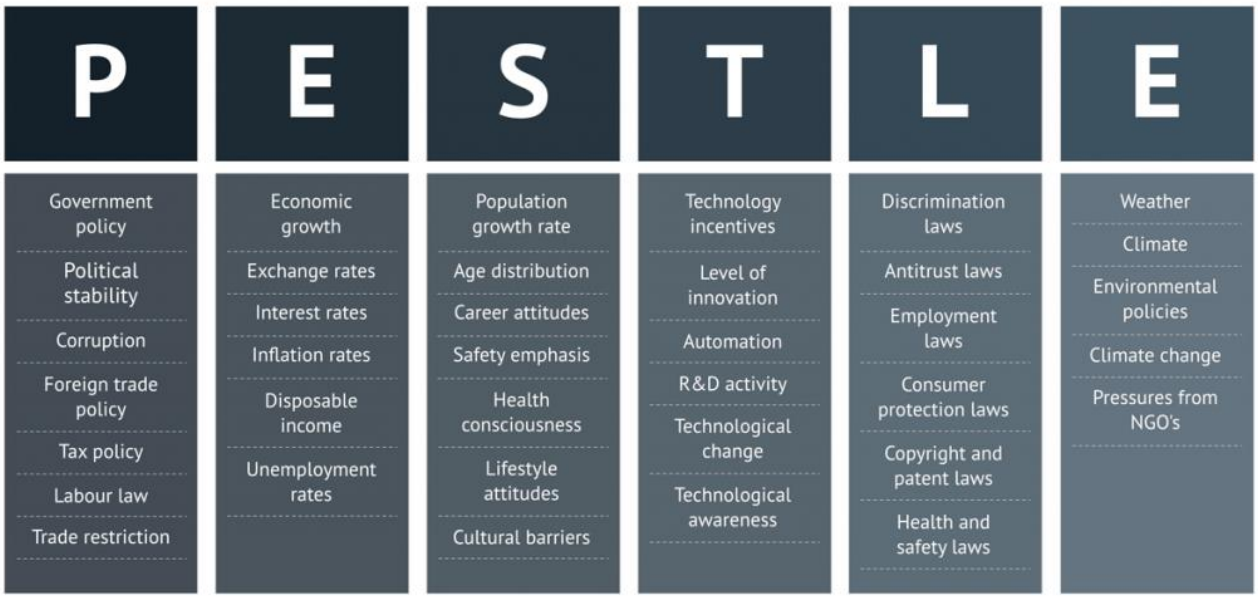

Figure 7 PESTLE framework (Consultera, 2023)

Typical factors that could be examined in each area are presented in the figure 7. As a result, the researcher makes a systematic and strategic assessment of the business' prospect, concentrating on internal and external factors.

Results

For understanding several factors affecting vehicle utilization in the transportation sector PESTLE analysis has been done. In the research, the electric and diesel technologies are compared from political, economic, social, technological, legal, and environmental dimensions, which affect the

freight road transport industry in Finland. For performing the analysis, the information from already existing documents, studies, and research has been used as well as data collected through semi-structured interviews with the truck manufacturer's company representative and legislator and through questionaries completed by companies ordering transportation services. By conducting PESTLE analysis, a better understanding of the current state and possible opportunities and challenges regarding diesel and electric trucks on the current Finnish market were presented and used as basics for providing driveline for the transportation company.

Political Factor

Comparison of diesel and electric trucks in political framework on the Finnish market should include several factors. The Finnish government has already introduced policies for promoting electric vehicles adaptation which includes financial support in purchasing the technology. As Finland is interested in reduction of emissions, this commitment is reflected in the policies in the transportation sector. Moreover, political stability is an important aspect of the governmental decisions, that is why the adaptation of electric heavy-duty trucks would be smooth, as that corresponds to certainty of society, investors, and stakeholders, operating in the transportation sector.

Another crucial tool by which the government could influence the usage of the mentioned technologies is the taxation system. According to the interview with Traficom's representative, taxes for diesel and electric trucks do not differ significantly, as the current tax systems relies of the number of axels rather than on produces emission. Introduction of tax based on the emission rate is not planned to be developed in the nearest future for heavy-duty trucks in Finland. However, the tax for the refuelling significantly differs. The price for the diesel is higher in comparison to the price for the electricity due to the higher tax included. Therefore, means that for running operations on diesel truck the company will spend more in comparison with electric alternative.

As diesel fuel is a subject for higher taxes, it is resulting in higher prices in comparison with electricity, so this could impact significantly on the operational expanses of Solid Way OY that mostly offers transportation services on the Finnish market. Cost advantage in terms of lower fuels prices of electric fleet could be a potential saving in company's expenses, especially considering the

empty-running return trips. Solid Way Oy is not a large corporation; thus, it is crucial to understand, analyse expenses and try to find the way to cut costs.

Economic Factor

Comparing the diesel and electric truck utilization in the transportation industry, it is worth considering the purchasing price of the technology. While diesel trucks are cheaper to purchase upfront, it is noted that they have higher operational and maintenance expenses in comparison to electric trucks, based on the truck manufacturer's interview. Electric vehicles have fewer components and moving parts, which means a lower need for maintenance, which reduces costs. Moreover, diesel fuel is more expensive in comparison to electricity, so the operating cost is lower for the electric truck. It is stated that the utilization of diesel trucks means a high dependence on imported oil, as Finland is lacking this source. However, for running out the electric truck and producing electricity for them domestic renewable resources could be used. At the same time the infrastructure needed for diesel truck operations is already available and working around the world. The transportation activities run regularly and smoothly. However, switching to electric vehicles would require significant investments in infrastructure. The power grid should be updated to meet the increased demand for electricity, which could be also costly for the county's economy. Currently, transportation company is the responsible part for ensuring the availability of power stations for their fleet, that is why for SMEs such as Solid Way OY investing in infrastructure would be costly, therefore would cause additional financial burden.

Finally, according to the information from truck manufacturer, based on their calculation including different requirements in distance ranges, gross weights, and weather conditions, the total cost of ownership (TCO) is lower for the electric truck in comparison to the diesel one, so that makes it a more attractive technology for transportation companies. Moreover, according to Traficom representative, the Finnish government offers a financial support (forty thousand euros) for purchasing the electric truck to promote electromobility and ease the financial burden on the transportation company. Truck manufacturers, for example Volvo, could provide estimations for TCO and emerging expenses based on the company's background.

Diesel truck is a traditional way of running transportation services, it is a profitable and reliable solution based on experience of Solid Way OY; it is possible to purchase for a fair price and in good condition the resale truck. However, electric truck could be bought only from truck manufacturer, it requires extra investments in infrastructure, maintenance, repair expenses and residual value are not clear yet. That is why for SMEs it is risky to purchase the electric fleet, even though TCO is expected to be lower. Such an investment of money should be carefully analysed beforehand and the return on investment should be estimated.

Social Factor

Diesel and electric vehicles have different social impacts, which would be presented further. For centuries, diesel truck was a primary choice for transportation companies in Finland, creating a wide variety of job positions and interconnected businesses in different industries. However, recently people have started warning about the emissions and other air pollutants produced by the operations of diesel trucks, as they are harmful not only to the environment but also to human health and lifestyle.

It is worth mentioning that based on the information from truck manufacturing insider, alternatives for diesel trucks have been recently sought by different transportation companies operating in Finland for running more environmentally responsible operations for their customers. The electric truck is one of the solutions for enabling that request in the transportation industry. It was mentioned that demand for electric heavy-duty trucks is increasing, as customers of transport companies are looking for sustainable solutions. Society's awareness regarding ecology is increasing from year to year.

Even though the shift towards electric trucks could be disruptive for the current market in terms of industries and businesses that tend to operate with diesel vehicles, there are a lot of opportunities for new job generation in sectors such as manufacturing, developing, and maintenance etc, that would serve modern technology on the market. Adapting electromobility and switching to this concept could be challenging as it arises the need for personnel retraining and organizing courses for acquiring new knowledge, skills, and technic for workers. Furthermore, the electric truck is a promising alternative for reducing air and noise pollution in urban areas, preventing respiratory

illnesses, and improving quality of life. It is worth mentioning, that based on the surveys with customers of Solid Way OY, ordering transportation services from the company, there are big organizations, which would accept extra costs for more environmentally friendly cargo transportation if the organization could provide that. It is worth mentioning, that this corresponds mostly to customers from Europe, working with Solid Way OY, however at the same time Russian partners prioritize the cheapest and the fastest solutions.

Technological Factor

While comparing the electric and diesel trucks it is worth presenting the current technological state and the way it affects the operations of the mentioned technologies. While diesel truck is commonly used in the transportation sector and is a well-known technology, tools, and methods for maintenance and repair are known everywhere, the electric truck is an innovation, that would need specific skills and knowledge for working with it. Nowadays there are no unique international technology development instructions, that harden the electric truck adoption. This technology is not compatible with any existing one and there is a significant gap in electromobility utilization in developing and developed countries. Moreover, the production of some parts for electric trucks is still under pilot projects and it is a developing industry, therefore leading to limitations in capacity, driving range, and charging time. Furthermore, the utilization of electric trucks in a business environment requires significant IT support and software adjustment based on the organization's requirements and specifications.

According to an industry insider representative, electrification is not ready for long-haul transportation nowadays, as there are no available infrastructure and battery technology is not developed for distances more than 400 km. However, it could be applicable for heavy-duty trucks with semi-trailers for transporting cargo over this range. Nowadays, the responsible side for installing the charging stations for the vehicle is the transportation company itself, however in the future perspective that could be under the control of the government. At the same time, the diesel-powered truck currently used in the company and transporting cargo could cover up to 1 900 km without refuelling. Furthermore, one more important aspect influencing the operations of the vehicles is the weather. Snow and rain affect the consumption of electric trucks, which increases by up to 30%. However, it is worth mentioning that harsh weather condition has a significant impact on

diesel consumption as well, as it could increase by up to 20%. In both cases that shortens the distance trucks could operate.

Looking at the future perspective, provisional agreement for alternative fuel infrastructure should be highlighted. This proposal aims to ensure the availability of sufficient infrastructure for recharging and refuelling and enlarge its coverage in Europe. European Council (2023) has stated that the Commission is focusing as well on fundamentals "for recharging heavy-duty vehicles and requirement for TEN-T coverage by 2030, starting in 2025". The proposed agreement considers the Finnish perspective and enables the transition to a sustainable road freight network and improves the infrastructure and environment for electric truck adoption.

Another important aspect that should be considered is the needed time for refuelling the vehicles. For the diesel truck, it is needed 6-15 mins for refilling the tank, which depends mostly on the size of the tank. For charging the electric truck approximately 2,5 hours are needed, however, the required time depends on the battery used in the vehicle and the power of the charging station. Another drawback of the electric vehicle is its limitations in the gross weight of the coupling vehicles. According to the Finnish Transport and Communications Agency (2020), it is allowed to have 76t of gross weight for the coupling vehicles. While diesel trucks would be able to carry out these weights, the electric truck is limited to 44t on average. This aspect creates some barriers in the weight of the transported cargo for electric vehicles, which should be managed carefully.

It would worth mentioning, that based on the requirements of Solid Way Oy, electric truck would be able to cover transportation needs from Kotka to the boarder with Russia and back for delivering light and medium weight cargos. Moreover, there is no need for looking for charging stations on the route, as the electric fleet would be able to cover it fully without extra chargers. However, for the current year electric truck will not be able to cover all needs and orders of Solid Way OY in terms of distance and weights range. In the future perspective after charging stations installation, it would be possible to transport cargo not only from Kotka, but from Helsinki port as well. However, there still could be limitations in gross weight of coupling vehicle with container, which should be examined further.

Legal Factor

This paragraph would examine the regulations and standards that govern the operation of diesel and electric vehicles. It is worth mentioning, that regarding safety regulations, there is no difference among the mentioned technologies, used in the transportation industry. The same regulations and laws are controlling the freight industry, despite the different natures of used vehicles. However, it is worth saying that the framework for regulating electric vehicles is still being examined, and different jurisdictions adopt various strategies, so the legal factor is likely to continue to change in the upcoming years. Some general patterns have emerged, such as the requirement for specialized infrastructure for electric vehicles and tax policies.

Nevertheless, as Finland is part of the European Union it is supposed to follow the regulations of the union regarding the reduction of greenhouse emissions, thus leading to the introduction of goals and action plans in reducing the carbon footprint on the national level. Finland has already introduced strict emissions standards for diesel trucks to lessen the impact of transportation on the environment and has started promoting the adaptation of electrified fleets by providing financial incentives, which have been presented earlier.

Looking at the future perspective it is worth mentioning the new emission standard Euro 7 that would enter into force for heavy-duty trucks in July 2027. According to European Commission (2022), a new regulation will cover not only internal combustion engine vehicles but also set requirements for electric ones. More strict limits for emissions and several types of pollutants will be set for vehicles irrespective of the source of power whether it is petrol, diesel, electricity, or alternative fuels. Moreover, new standards have set requirements for battery durability used in electric vehicles. The introduction of the new standard was welcomed by the Association for Emissions Control by Catalyst (AECC), which urged the European Parliament and Council to adopt the rules as soon as possible.

Even though there is an arising agitation, if manufacturing of diesel trucks could be prohibited in the nearest future on the official level in the European Union, there is no doubt that the heavy-duty vehicles industry is not ready for such changes in the coming years. Trucks with internal combustion engines could cover long distances transporting huge volumes of cargo, that electric vehicles are not capable to perform. It is believed that several possible ways could improve the environmental performance of diesel engines, which would be developed and evaluated in the coming

future to reduce the carbon footprint. Already in 2023, the European Commission has proposed a revision of the Regulation on CO2 emission standards for heavy-duty vehicles. After its adaptation, stronger CO2 emissions standards will be introduced for manufacturers of heavy-duty vehicles from 2025 onwards. The targets are to reduce emissions by fifteen percent by 2025 and by thirty percent by 2030 in comparison with the EU average in the reference period 1 July 2019 –30 June 2020 (European Commission, n.d.). Currently, the proposal should be reviewed and confirmed by the European Parliament and the Council of the EU for entering into force further.

Overall, Solid Way Oy thoroughly understand and comply with existing policies and regulations. Current fleet ensures safety and meets emissions requirements. Electric truck would meet both aspects as well. From the legal perspective, currently, there is no difference between running operation on diesel or electric trucks, however it will be important to overview future perspectives, such as stricter emission limits, and implement them in the company's strategy and development.

Environmental Factor

Awareness and concerns of environmental matters such as air pollution and climate change have been recently reviewed in the world, therefore there is a growing trend in emissions reduction. As could be seen from the emission calculations for operations of Solid Way OY, the electric truck is a more sustainable end environmentally friendly technology in comparison with the diesel vehicle. Electrification of road transportation is a promising alternative for reducing carbon footprint in the logistics industry. Moreover, Finland has a high share of renewable resources that could be used for generating electricity for trucks in a sustainable way. As it was mentioned earlier, environmental pollutants generated in the freight road industry play a vital role in climate change globally, that is why actions on the governmental level regarding the production and usage of diesel vehicles could be introduced and put in force recently.

Furthermore, the concept of circular economy that is promoting sustainability could be applicable for the electric trucks. According to the industry insider, the manufacturing company takes responsibility for extending lifetime of the battery, which could not be used for running vehicles after approximately eight years. For example, Volvo has developed the programme for repurposing the battery for energy storage applications after the end of truck's life. This concept saves resources,

reduces the need for new batteries production, and provides second lease of life and possibility to be reused for the already existing ones. Comparing diesel and electric truck in the freight sector in Finland it is worth mentioning that electric truck is a more attractive technology, as it emits zero emissions during operational processes contributing to an environmentally responsible future.

7.4 Summary of results

As the data has been examined from various perspectives, it is necessary to summarise the results in one place and merge them for visualizing the study's overall results (see Table 2).

Table 2 Summary of results

	Diesel truck	Electric truck
Political Aspect	Emissions do not affect the tax for the vehicle, and it is not planned to include this aspect in the tax and put in force in nearest future. High taxes for the source of power. High taxes on source of power significantly impact the finances of a company.	The government has introduced policies promoting adaptation of technology. Same taxation system for the truck itself. Low taxes for the source of power. Lower taxes of sources power could reduce operational expenses for the company.
Economical Aspect	Lower purchasing price. Higher costs for maintenance and repair operation. Source of power (diesel) is more expensive. No governmental financial support. Needed infrastructure is available and do not cause extra costs. Well-known profitable technology commonly used in transportation companies. Current fleet ensures smooth operating process followed by stable revenue generation.	Higher purchasing price. Lower costs for maintenance and repair operations. Source of power (electricity) is cheaper. Governmental subsidy (40 000€). The company need to invest into charging infrastructure. Unclear picture about total cost of ownership, however truck manufacturers expect lower figures. Quite risky and serious investment for the company followed by unclear picture of possible expenses.

Social Aspect	Primary choice, well-known technology for company workers and investors. Plenty of work possibilities and workplaces in interconnected industries. Harmful for human health and lifestyle. Small companies rely on well-known solutions and do not want to risk and pay more for alternatives.	Shift to this technology could be disruptive for the labour market. However, new opportunities, job positions and businesses could appear. Global companies are looking for sustainable logistics. Customers are ready to pay more for sustainable transportation services. Willingness of some customers to have sustainable solutions creates support in shift to electric fleet.
Technological Aspect	Well-known technology, mechanics could operate easily with it. Distance range: appr 1900 km Refuelling time: 6-15 mins Gross weight: 76t Available infrastructure everywhere. Covers and fulfils all requirements and needs of the company.	Innovation requires special knowledge and skills in working. Distance range: appr 400 km Refuelling time: 2,5 hours Gross weight: 44t It is planned to install charging stations for TEN-T routes by 2030. Suitable for transporting only part of company's workload.
Legal Aspect	Currently same regulation and laws control the road freight industry. Strict emissions standards for diesel trucks. Introduction of Euro 7 would affect the industry in contest of emissions. Manufacturing of diesel heavy-duty truck would be developing; it will not be prohibited. Current fleet in the company follow all regulations and laws put in force.	Same regulation and laws control the road freight industry, however framework for regulating electric vehicles is still being examined. Introduction of Euro 7 set requirements for the batteries. In context of commitment to reduce carbon footprint, electric truck could be an option, but not mandatory.
Environmental Aspect	Negative impact on the environment, air quality and climate due to polluting emissions while running operations. One truck emits appr 75t of CO2 annually based on needs of company.	No emissions while operating process. Possibility to extend lifetime of the vehicle's battery in energy storing application. Sustainable solution for the company and its customers.

8 Discussion and conclusion

Having conducted a comprehensive analysis and comparison of diesel and electric trucks in the context of Solid Way Oy, it is advisable to continue performing operations with the current fleet of diesel trucks as it is a more prudent and reasonable approach for the organization, considering its status as a small and medium-sized enterprise (SME). Even though electric trucks are more beneficial from social and environmental perspectives, several risks and challenges could be seen from the analysis. The current fleet is a reliable choice and well-suited technology that could cover all company's needs on the current market, that is why it would be more prudent for Solid Way Oy to keep operations with diesel trucks nowadays. However, developments on the electric truck market and changes in the regulatory framework should be considered regularly. The approach presented would enable risks to be mitigated and operational stability to be ensured while opportunities for sustainability and efficiency improvements in logistics operations are still being examined.

The ideas on answering and supporting research questions are discussed and concluded, interpretation of the relationships between key results and knowledge base is examined, implementations for future research are presented further. Additionally, the assessment of the research, its validity, reliability, and ethical compliance are addressed.

8.1 Acquiring the research objectives and answering questions

The main objective of this study was to compare current diesel-powered fleet and electric alternative from several perspectives and give some suggestions to the company regarding choice of driveline on the current market by reviewing relevant literature and analysing the gathered data from several aspects. Based on the literature review, data collection, analyses, and results, the research questions are answered below:

1. What are the impacts of diesel and electric trucks of company's operations on the environment in terms of greenhouse gas emissions?

The negative impact of road transportation sector was comprehensively observed in the literature review. It was noted that diesel trucks emit pollutions that negatively affects the environment and

climate, while electric trucks could be a potential alternative for reducing greenhouse gas emissions. In the conducted study the focus was on the emissions produced only while transporting and running operations. Based on the data obtained from the company regarding working environment, requirements and workload of the operations, emission calculation has been performed by the researcher applying the methodology recommended by the European Commission and showed up that single diesel truck annually produces up to seventy-five tonnes of emission. It would worth mentioning, that actual emissions may vary depending on various factor and the research was done on average variables. It could be noted that the current diesel fleet's emissions are substantial. On the other hand, electric trucks do not produce any emissions while transporting products regardless the weight of the cargo and the need for the delivery distance. Based on the information provided and the conducted analysis, it can be observed that electric trucks have the potential to significantly reduce and eliminate emissions during the transportation process, whereas the environment is negatively impacted by diesel trucks.

2. What factors influence the usage and performance of diesel or electric trucks in the Finnish company nowadays and what are the impacts of these aspects?

The use and performance of diesel and electric trucks in a Finnish company is influenced by several factors. Among them are economic considerations such as the economic viability of the choice between diesel and electric trucks, including purchase costs, operating costs, and maintenance costs. Financial incentives or subsidies provided by the government for electric trucks also affect their usage. In our case it was found out that the Finnish government provides subsidy for purchasing electric truck, however investment in new technology is still quite serious for small and medium-sized company such as Solid Way OY. Moreover, the full picture of finances while operating on electric truck is not clear, whilst the diesel-powered truck has long been a reliable way to run business in transportation industry. Furthermore, environmental legislation, policies and public awareness of sustainable development and the environmental impacts of transport can affect the use and performance of diesel or electric trucks. Electric trucks, as emission-free vehicles, are considered to be more sustainable solution in comparison with diesel trucks, which emit greenhouse gases and pollutants during operation. In addition, the use and performance of both technologies is influenced by the technological advances such as capacity, reliability, range, and available infrastructure. It was found out from available literature and interviews with company's

representative that the current diesel-powered fleet could fully cover all needs and do not require additional investments in infrastructure. While interview with truck manufacturer has showed up that electric heavy-duty truck still has limits in distance range and capacity that creates barriers in workload. Finally, interview with legislator from Finnish Transport and Communications Agency raised legal factors such as emissions standards, limitations in dimensions and taxation system. However, it was noted that the choice of electric or diesel truck is not really affected by the legal requirements and laws in Finland at current state.

Besides typical characteristics the operational needs and requirements of the company should be considered and valued while choosing the fleet for logistics. The choice between diesel and electric trucks could be influenced by the availability of refuelling infrastructure on routes, customer requirements on delivery times and flexibility in logistics operations. It was found out that currently the company is the responsible side for ensuring the availability of needed infrastructure on the route for electric trucks, while for diesel truck needed refuelling stations are widely available. As a result, the use and performance of diesel and electric trucks in a Finnish company is influenced by several factors, including economic, environmental, technological, legal, social, and operational aspects. The detailed effect of every factor on the examined types of vehicles have been presented earlier and could be found in the Table 2. The decision on choosing technology between diesel and electric trucks represents the result of the combined effect of these aspects and the company's related needs and requirements.

Overall, the conducted analysis showed up that diesel-powered truck remains an important technology in the nearest future and continues to be advantageous due to already available infrastructure and needed knowledge about the vehicle followed by low purchasing costs. However, it still produces high volumes of greenhouse gases that negatively affect the environment, climate, and humans' health. It would worth mentioning that electric alternative does not have same problem with emissions while transporting cargo, however it is limited in payload, distance range and experience in working with new type of vehicle. Additionally, shortage of needed infrastructure and clear financial picture creates drawbacks in technology adoption.

3.What driveline should a company choose for road transportation on the current market?

From the literature review it was unclear if electric or diesel heavy-duty truck is the most suitable technology for running operations on the current market, as both technologies have advantages and disadvantages. That is why more comprehensive and detailed research was needed based on the requirements and business environment of the company Solid Way OY. Thorough analysis and comparison of diesel and electric trucks conducted by the author has presented several insights regarding both technologies in the context of a target organization. Besides being a sustainable technology electric truck is a subject for several risks and challenges influencing the work of the organization. For small and medium sized enterprises investing in such innovative technologies does not worth the possible risks. The final statement about the financial aspect cannot yet be derived due to the lack of experience with electrified heavy-duty trucks in Europe. Furthermore, there are still a couple of challenges such as lack of technological development and the lack of well-established and supportive system for electric trucks which increase uncertainty in operational and regulator aspects. Nowadays, the company is able to perform operations, keep position on the market, stay profitable, and satisfy customer's needs with the current fleet ensuring stability and reliability of the organization. Based on the results, current diesel fleet was chosen by the author for ensuring smooth running of operations on the current market.

8.2 Research validity, reliability, and ethical compliance

While conducting the research it is important to ensure reliability and validity. According to C. Kothari, validity of the conducted study refers to truthfulness of the results and outcomes including the usage of relevant sources of information and accurate implementation of the measurement and analysing tools.

During the research the author has implemented both the qualitative and quantitative approaches. The researcher has examined the internal background information of the company Solid Way OY and its operating environment and requirements. For the quantitative research part, the author has conducted interviews with industry insiders, overviewed current literature and performed analysis. Regarding performance of the qualitative part, the researcher has conducted the deep study of primary and secondary data sources followed by supervision from the company and insights from interviews with industry representatives and surveys for the organization's customers. All information was gathered, analysed, and presented based on ethical principles, legality, and objectivity.

Reliability is another important aspect that should be considered in the research. It refers to providing and ensuring the consistency of the research results. Stability and equivalence are the main two aspects of the reliability. Stability means that the results would be the same if the researcher will perform same measurements and analysis. Equivalence refers to the presence of errors in the study (Kothari, 2004).

A systematic retrieval of source material from reliable and reputable sources was included in the research. The author of the study has selected databases, academic journals and publications, industry reports, official government websites based on their relevance and reliability to ensure using valuable information related to the examined topics. The retrieved sources have been assessed based on the credibility of the publication's authors, currency of the publication and its accurate manner of presenting information. A wide range of perspectives, theories, studies, and viewpoints were covered in the chosen sources ensuring a well-rounded and not biased analysis. Additionally, the information gathered through interviews with respondents having valuable experience and knowledge about the industry and through surveys with company's customers fulfilled the research. Relevant and thorough information related to the study was used in the research for enhancing the integrity and validity of the conducted work.

It should be mentioned that the analysis and results of the conducted research work are performed according to Solid Way OY's individual needs: the host company's operating requirements, current used fleets, running distances and others are variables that drive the output of the case study. In case of external reliability and validity, acquired results could differ in other transportation companies' cases. However, the research methods and analysis techniques used in the research could be implemented to other businesses.

Research ethic guidelines were examined carefully by the author and addressed through the study. The ethical considerations were critically analysed, so appropriate measures were taken and implemented. Analysis and use of literature and documents in the research were conducted with strict adherence to ethical principles followed by correct citation and sources marking. Information used from the external resources was used responsibly in an ethical manner followed by maintaining the integrity of the original study. Furthermore, the research does not contain any

personal or confidential information, that could not be shared to the public. It would worth mentioning that participants of interviews and surveys were informed in advance about the purpose and nature of the study that was performed without any violation of confidentiality or privacy of the participants. Moreover, the author of the research has carefully reflected and used the information in the study considering the company's reputation and its position on the market.

8.3 Implications for future research

The aim of the study was to provide the analysis for the transportation company regarding factors influencing the adaptation and performance of two types of vehicles on the Finnish market. Conducted research has covered political, legal, social, technological, and environmental aspects of running operations by different technologies.

As electric truck is an innovative technology that is still under development and not widely used nowadays, there is a need for ongoing research for analysing needed maintenance and repair operations tailored by specific needs and requirement of the company. Such research could deepen the presented analysis and fulfilling it with valuable insight affecting the financial part of vehicles' utilization. It could be possible to make research of the economic part of acquiring alternative technologies to the company's fleet. Currently electric trucks are not so common on the market, that is why it is tough to estimate most of the costs included in the vehicle's operations.

Furthermore, as electrified fleet is not the only alternative technology to the diesel one. It is possible to conduct the same research for hydrogen fuel cell, natural gas, biofuels, or hybrid trucks that could be a replacement for the diesel vehicles based on the results of the research.

Finally, this research's theoretical part could be applied as a basis for additional studies in a related area. The conducted literature review is trustworthy since enough reliable scientific sources were included.

8.4 Reflection on the research

The author of the research has developed an interest in the topics of transportation sector and sustainable business models during studies at JAMK University of Applied Sciences. The requirements of the target logistics organization and current trends were correlated with the interest in the mentioned topics. The author has improved both theoretical and practical knowledge throughout the research by reading a variety of literature and gathering and analysing data. Additionally, experience of conducting a sizable practical assignment personally was acquired. The researcher believes that the study has been successful and could be used as the base for the more detailed projects in the future perspective. The conducted study has showed up how limited is the available information regarding innovations, however on the other hand a vast of possibilities for scientists are available as numerous potential research avenues remain unexplored in the transportation sector.

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Appendices

Appendix 1. Interview questions with industry insider and truck manufacturer

Background information

Company Name:

Name of the interviewer:

Position:

Data of interview:

Questions

1. Could you please talk about the performance characteristics of electric trucks, particularly in terms of range, payload capacity, electricity consumption, gross weight?
2. What can you tell about maintenance and repair operations? Do you have any estimations regarding possible costs annually in comparison to diesel truck?
3. How do weather conditions affect the work of electric truck?
4. Are there any regulations from the European Union that affect the manufacturing of diesel trucks in terms of emissions etc.?
5. What is the estimated cost of purchasing an electric truck, compared to a diesel truck?
6. What kind of charging infrastructure is required for electric trucks?
7. What do you know about the infrastructure available in Finland nowadays?
8. How long does it take to charge an electric truck?
9. What kind of warranty and after-sales support is available for electric trucks?
10. What are the key technical challenges that need to be addressed in order to improve the performance and usability of electric trucks?
11. How do you see the market for electric trucks evolving in the coming years?
12. Do you believe that the Finnish market is ready for electrification in road freight transportation industry?
13. Will it be possible to use electric truck with trailer or semi-trailer used with traditional trucks?

Appendix 2. Interview questions with company represenative

Background information

Company Name:

Name of the interviewer:

Position:

Data of interview:

Questions

1. What kind of expectations or requirements for sustainability does your customers have?
2. Generally, what does sustainability mean for your company?
3. Could you describe the working environment, customer needs, current state of the company (fleet, workload etc)?
4. When have you started thinking about embedding the sustainable approach into logistics operations and why?
5. Are there any more sustainable activities that have been implemented recently in the company's operations?
6. Is sustainability and its measurements is mentioned somehow in contracts with customers and third parties involved in logistics?
7. What features and aspects are usually covered in contracts?
8. What are your future plans regarding implementation of sustainability concept in the organization?
9. Are you ready to invest into sustainable solution?
10. Have you heard about governmental support and incentives in sustainability in Finland?
11. Divide 100 percent for the aspects below based on their importance when your company's customer is choosing the logistics solution:
    - Price for the service
    - Time framework
    - Door-to-door delivery
    - Sustainable way of transportation

Appendix 3. Survey questions with company's customers

Background information

Company Name:

Country:

Name of the interviewer: (could choose to stay anonymous)

Position:

Data of interview:

Questions

1. What services do you order from Solid Way OY?
2. How important is environmental sustainability in your company's decision-making process when it comes to choosing a transportation solution? Do you consider it at some point or not? If no, why?
3. What factors do you consider when selecting a transportation service provider? Divide 100 percent for the aspects below based on their importance.
    - Price for the service
    - Time framework
    - Door-to-door delivery
    - Sustainable way of transportation

1. Do you consider anything else?

4. Will you accept paying more for making delivery process more sustainable? How much more? (You can present your answer as percent)
5. What are your concerns about using transportation services that use electric trucks? (e.g., range anxiety, availability of charging stations, maintenance costs)
6. Have you ever used electric trucks for your transportation needs? If yes, how did they compare to diesel trucks in terms of performance and cost?
7. Do you think that companies should prioritize environmentally sustainable transportation solutions, even if they may be more expensive in the short term?

Appendix 4. Interview questions with Traficom representative

Background information

Name of the interviewer: (could choose to stay anonymous)

Position:

Data of interview:

Questions

1. What are the current limitations for dimensions and weights for coupling vehicles in Finland nowadays?
2. From the perspective of Traficom, what are the main political and legal factors affecting the adoption of electric trucks in Finland compared to diesel trucks?
3. How do taxes on diesel trucks and electric trucks differ in Finland, and how does Traficom view the potential for changes in tax policies in context of trucks?
4. Is emission factor included in the taxation system for trucks?
5. How do you see the adaptation of the electric heavy-duty trucks in Finland? What challenges and drawbacks does this technology have?
6. What incentives or support programs from the government are available to encourage the shift towards electric vehicles in Finland?
7. What is the size of financial support is available currently for purchasing electric heavy-duty truck?